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WDMUtil Version1.0 (BETA)

A Tool for Managing Watershed Modeling Time-Series Data User's Manual (DRAFT)

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A Tool for Managing Watershed Modeling Time-Series Data

User's Manual (DRAFT)

Exposure Assessment Branch
Standards and Applied Science Division
Office of Science and Technology
Office of Water
United States Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

Disclaimer

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WDMUtil was developed by AQUA TERRA Consultants under contract number 68-C-98-010. Mr Paul Hummel was the Project Manager, responsible for the design, implementation, and testing of the program, with technical and administrative guidance provided by Mr. Anthony Donigian and Mr. Jack Kittle. Mr. Mark Gray assisted in the programming and documentation efforts, and Mr. Paul Duda performed selected testing tasks.

User Assistance and Technical Support

EPA's Office of Science and Technology (OST) provides assistance and technical support to users of WDMUtil. Technical support can be obtained as described below:

1. **OST's Internet Home Page:** WDMUtil users are encouraged to access OST's home page for information on new updates, answers to the most frequently asked questions, user tips, and additional documentation.

EPA OST's Internet home page address: **http://www.epa.gov/ost/basins**

1. **Telephone assistance:** OST Personnel are available to assist potential users with technical questions regarding system installation and data development. Inquiries on the BASINS system can be directed to:

- Marjorie Coombs-Wellman, tel. (202)260-9821, e-mail **wellman.marjorie@epa.gov**

- Paul Cocca, tel. (202)260-8614, e-mail **cocca.paul@epa.gov**

Contents

1 Introduction

1.1 Background and Objectives

One of the abilities of the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)(Lahlou and others, 1998) tool is to perform nonpoint source modeling using the NPSM model. The NPSM model contains the Hydrologic Simulation Program- Fortran (HSPF)(Bicknell and others, 1997). In order to successfully apply NPSM or HSPF, meteorological data local to the area being studied are required. The current version of BASINS contains an average of 10 meteorological stations per state. These data are stored in the Watershed Data Management (WDM) format, which is used by both BASINS and HSPF. WDM files and the code library which manages them provide a powerful tool for managing and manipulating time-series data. However, to create and work with WDM files requires a significant level of user education. BASINS users would greatly benefit by having a straight forward, easy-to-use tool that would enable them to update or build WDM meteorological files without learning the detailed logistics of WDM operations. This tool is WDMUtil.

The WDMUtil program provides operational capabilities to allow users to import available meteorological data into WDM files and perform needed operations (e.g. editing, aggregation/disaggregation, filling missing data, etc.) to create the input time-series data for NPSM/HSPF. WDMUtil will allow the user to add available local meteorological data to their study, thus removing the existing reliance on the limited set of meteorological data stored in BASINS.

1.2 Capabilities

WDMUtil provides a variety of features to assist in the compilation of meteorological data for use by the BASINS and HSPF models. These include:

- reading time-series data from standard and user-defined formats,
- summarizing periods of missing or faulty data for a time series,
- listing time-series values for viewing, printing, and saving to a file,
- editing time-series values,
- generating time-series and comparison plots,
- computing new time-series data using existing data,
- disaggregating existing time-series data from daily to hourly values, and

- writing time-series data to WDM data sets.

WDMUtil uses a graphical user interface and a context-sensitive help system to aid the user in performing these functions. It also allows the user to store data on WDM files without the user needing to understand the technical details of the WDM format.

Previously, these tasks were performed using DOS-based programs. Interfacing with WDM files was performed using the ANNIE (Flynn and others, 1995) and IOWDM (Lumb and others, 1990) programs (see **http://water.usgs.gov/software/surface_water.html** for links to these programs). Summarizing and correcting missing data, computing new data, and disaggregating data were performed using the METCMP program. It should be noted that WDMUtil does not contain all of the functionality housed in these programs. ANNIE allows for a much more involved level of interaction with WDM data sets including such functions as deleting and renumbering of data sets and viewing and modifying data-set attributes. METCMP also contains functionality not found in WDMUtil, most significantly the ability to disaggregate precipitation data. A recently developed tool, GenScn (A Tool for the Generation and Analysis of Model Simulation Scenarios for Watersheds) (Kittle and others, 1998), performs an expanded suite of utilities for analyzing time-series data.

1.3 User Interface

Graphical User Interface Conventions

WDMUtil was developed for user interaction to take place through a graphical user interface (GUI). Screens are organized in a logical manner to minimize both user learning time and user mouse/keystroke effort. Information within WDMUtil is often organized in layers, with the most basic and important information being readily available and more detailed and less frequently used information being accessed through additional menus or buttons. Another way that information may be layered is through the use of overlaid tabs, with the most frequently used tabs on top of the stack.

WDMUtil was also designed to assist the user in keeping track of where they are in the system. This was done by labeling all of the sub forms with titles that indicate the task being performed. This labeling also confirms to the user that they got to the right place in the system after selecting a menu option or button. The label on the main form is updated to include the name of the WDM file every time one is opened.

Selections from lists where more than one item may be selected is performed in the same manner as Windows 95/NT. Multiple selections are made using the Ctrl (control) and Shift keys on the keyboard. The Ctrl key is used to make multiple, but disjoint (not consecutive) selections. This is done by holding down the Ctrl key and clicking the desired items with the left button on the mouse. The Shift key is used to make multiple, consecutive selections. This is done by first selecting one item, using the left mouse button, at the start or end of the consecutive items to be selected. Then hold down the Shift key and

select the other end of the consecutive items. All items between the first and second selection will be selected.

Toolbars

Toolbars are used in WDMUtil to provide quick access to the most frequently used functions. Toolbar buttons contain tooltips, which provide a text description of each button when the mouse pointer is held over the button for a brief moment. Toolbars are provided on the main form of WDMUtil to work with the time-series buffer and the analysis tools.

Grids

Grid controls are used in several places for displaying tabular data. In some grids an entire row is selected as a unit while others allow selection of individual cells. The text from currently selected cells can be copied to the clipboard by pressing Control-C. This text can be pasted into another grid, into a different part of the same grid, or into an external program such as Excel by selecting the target location and pressing Control-V. Data can be copied from an external program into an editable grid in the same way.

If the selected target location has fewer rows than the copied text, the last rows of the copied text will not be pasted. If the selected target location has more rows than the text that was copied, extra rows will be filled with additional copies of the text as necessary.

Some fields in some grids are editable. Some fields are edited by typing a new value and others are changed by selecting a new value from a drop-down list. To edit a field, select that field and press Enter or simply begin to type the new value. If a drop-down list appears, a selection can be made using the mouse or using the up and down arrows on the keyboard. Press Enter (or Tab) to finish editing the value or press Esc to revert to the old value.

Some editable fields have soft and/or hard limits for acceptable values. The tool tip feature displays these limits while editing a value. If a value being entered is outside the soft limits, the background of the cell will be colored yellow to alert the user, but no other actions are taken. If a value is outside the hard limits or is incorrectly formatted, the background will be colored red. If the user presses Enter while the background is red, the value is changed back to the last acceptable value.

1.4 System Requirements

WDMUtil requires a computer running Windows 95 or Windows NT Version 4.0 or higher. The minimum platform configuration must contain:

- a 486 or equivalent processor running at 50 megahertz
- 16 megabytes of memory
- 40 megabytes of free disk space
- a display resolution of 1024 x 768

For optimal performance, a platform should contain:

- a Pentium or Pentium II processor running at 200 megahertz or faster
- 64 megabytes of memory

A color printer is also recommended.

1.5 Obtaining WDMUtil

WDMUtil may be obtained through the Internet by accessing the EPA OST's Internet home page (at: **http://www.epa.gov/ost/basins)**. From this page follow the instructions for downloading the software and installing it on your machine. The manual, containing the same text and figures found in the help file, is available as EPA document ???.

1.6 Architecture

A successful user interface for managing watershed modeling data displays information to the watershed modeler in a manner consistent with the modeler's world view and needs. The goal of the interface is to provide layers of information -- a summary of information about the project in the main form along with other forms that show additional information. This includes details about the data and methods for analyzing it.

The WDMUtil user interface has a main form that displays lists of scenarios that have been collected (for observed data) or developed (for computed data), and locations and constituents for which data are available. From the main form the user may analyze results by selecting desired scenarios, locations, and constituents and then selecting the time-series data available. A span of time and the analysis tool(s) are then selected to generate the desired data summaries, graphs, or lists.

The design of reusable components has played a key role in the development of WDMUtil. The result of using these components includes (1) reusability within WDMUtil (references from different locations or with different parameter sets), (2) reusability within other modeling systems, and (3) more easily defined and tested modules. Reusable components in WDMUtil include the date setting control, the range-checking numeric entry box, the editable spreadsheet-style grid, the file viewing form, and the graphs. A significant effort has been invested in developing a suite of modules for the graphical and tabular display of time-series data and other analysis results. The modules allow the programmer to set initial values for the parameters that define the plot or listing (for example, data values, number of curves/columns, text labels). All plots and listings can be customized by the end user.

Since WDMUtil is focused on working with WDM data, it uses the WDM FORTRAN library of subroutines for time-series management. A set of subroutines was developed to interface between the Visual Basic WDMUtil code and the existing FORTRAN routines. This allowed the well-tested and documented WDM code to be preserved. It is necessary for WDMUtil to incorporate different types of time-series data (that is, storage formats). To make WDMUtil work with these different data types in a consistent manner, a generic data structure was developed. Specific routines for each data type were written to fill the data structure. WDMUtil was then able to use this data structure in the same manner for all types of data.

1.7 Special Files

There are a variety of files either used by or associated with WDMUtil that should be noted. The Appendix provides detailed descriptions of each of these files and their contents. The following is a list of the files documented in the Appendix:

- Time-Series WDM - *.wdm, contains meteorological time-series data in format used by BASINS and HSPF,
- BASINS Information File - *.inf, contains information relating the contents of the Time-Series WDM file to BASINS,
- NOAA NCDC Export Format - *.ncd, a common, published format for exporting time-series data,
- WDMUtil Message WDM, contains essential information for WDMUtil to manage WDM files.

1.8 Sample Data

Sample data have been provided with the WDMUtil installation package for learning and demonstration purposes. The ‘sample.wdm’ and ‘sample.inf’ files reside in the ‘sample’ directory, which may be found in the directory in which WDMUtil was installed.

Although this sample WDM file was extracted from an original BASINS WDM file, it is only a subset of that WDM file and it has been modified for the purposes of the examples. No assumptions are to be made concerning the accuracy of the data on the sample WDM file.

2 Tutorial

This section presents detailed examples illustrating the use of WDMUtil in various project situations. The most effective way to use this section is by running WDMUtil and working through the lessons. This assumes that WDMUtil and its sample data have been installed on your computer. For instructions on how to obtain and install WDMUtil, see Section 1.5, Obtaining WDMUtil. The contents of the forms displayed in the tutorial documentation may vary slightly with what appears in the forms as the lessons are run. This is due to some of the lessons creating new data sets and is dependent on the order in which the lessons are performed. It is recommended that if you may want to rerun the lessons in the future, that you make a copy of the 'sample.wdm' and 'sample.inf' files before starting the lessons.

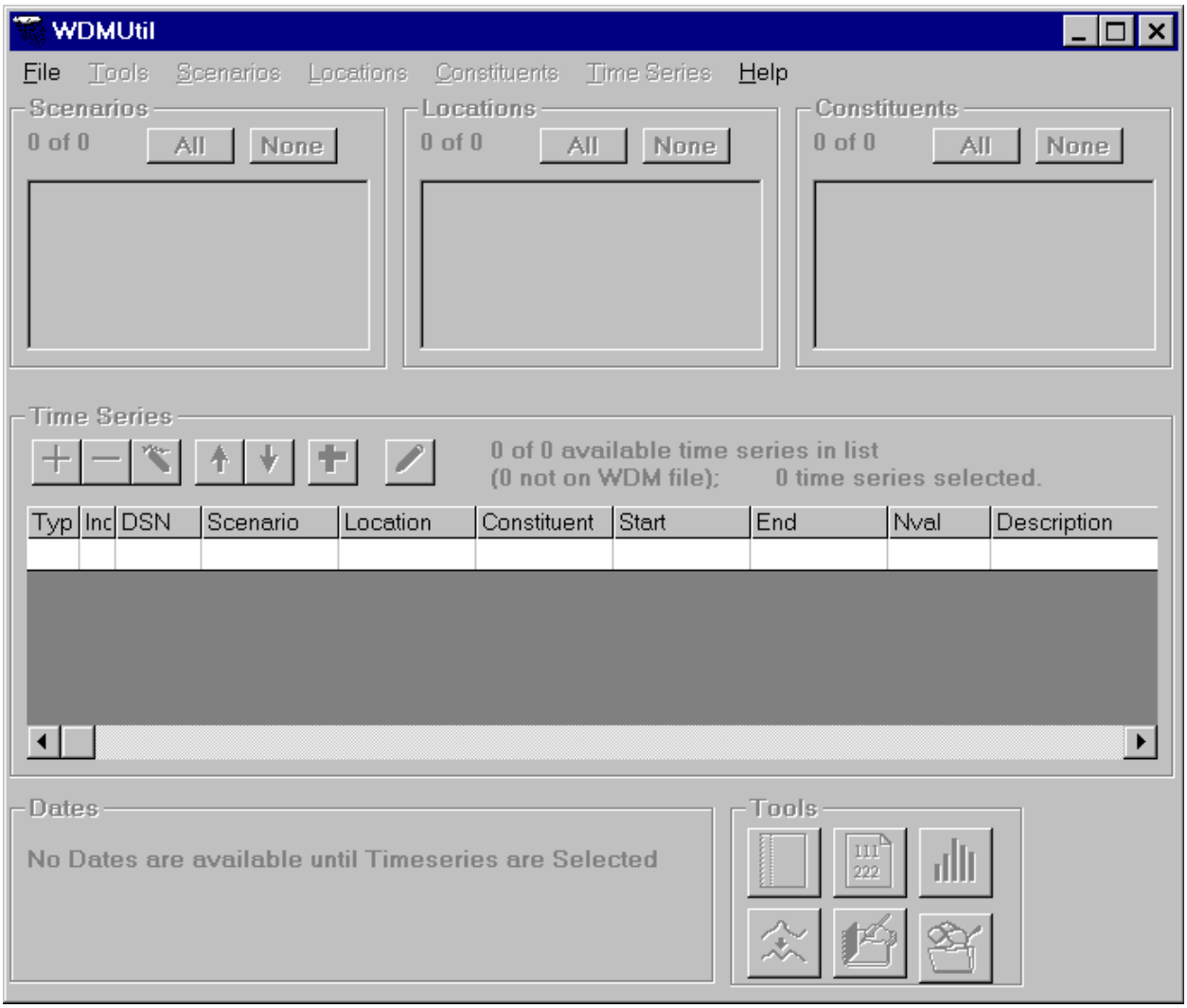
The lessons are intentionally basic to demonstrate how to perform functions. They also assume some familiarity with the topics being addressed. If you need more information than given in the lessons, detailed descriptions of the lesson topics may be found in other sections of the manual.

The list below gives brief descriptions of each lesson. The lessons may be grouped into four general categories: (1) becoming familiar with the basic mechanics of WDMUtil (Lesson 1), (2) accessing data for a new location and defining that location for recognition by BASINS (Lessons 2 and 8), (3) using tools that may be needed to refine data (Lessons 3 - 7), and (4) building a WDM file from scratch (Lesson 9).

- Lesson 1 is an introduction to WDMUtil and time-series selection.
- Lesson 2 shows how to access data external to WDM.
- Lesson 3 shows how to summarize data and report missing, accumulated, or faulty values.
- Lesson 4 shows how to list and edit time-series data.
- Lesson 5 describes how to build various time-series plots.
- Lesson 6 shows how to compute new time series from existing ones.
- Lesson 7 shows how to disaggregate existing time series into new ones.
- Lesson 8 shows how to write time-series data to a WDM file.
- Lesson 9 shows how to build a new WDM file.

2.1 Lesson 1: Introduction, WDM Open, and Time-Series Selection

In this lesson, WDMUtil will be started and a WDM file opened. The main WDMUtil form will be explored along with the help system. Exercises will then show different methods for selecting time-series data of interest for further review and analysis. To start WDMUtil, select it from the Start:Programs menu. The main WDMUtil form appears:

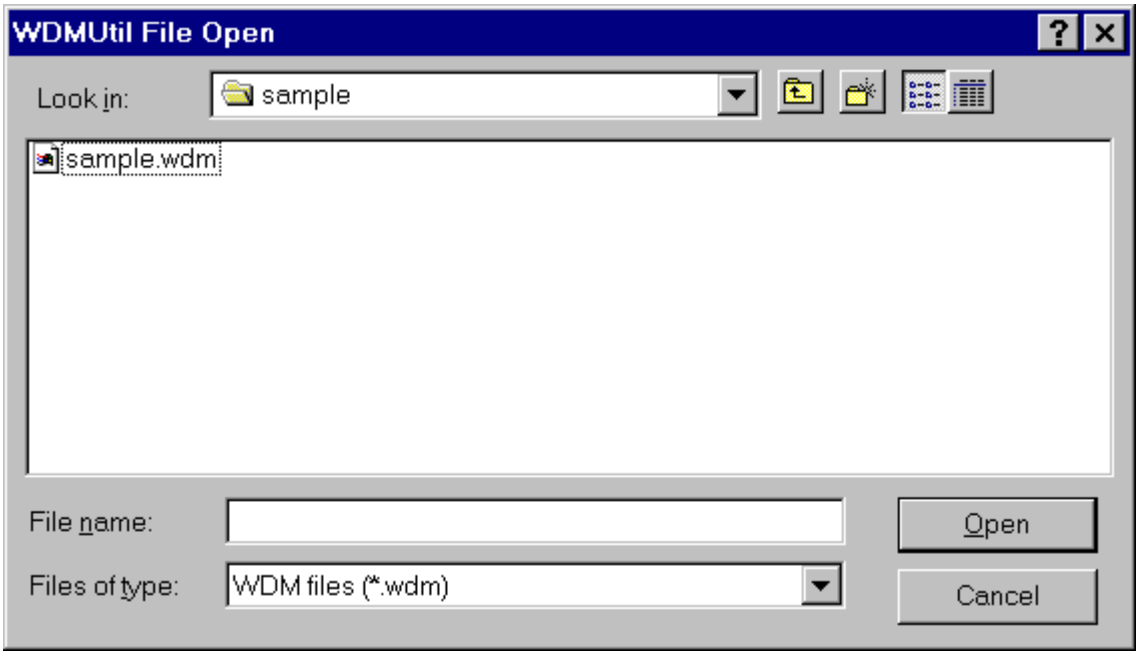


The main WDMUtil form is divided into a menu bar and six frames including Scenarios, Locations, Constituents, Time Series, Dates, and Tools. Each of the six frames is named in the upper left corner.

At any time when WDMUtil is being run, the complete manual is available online. To access the manual, simply press the F1 key. This command brings up the WDMUtil online manual open to a section appropriate to the current situation.

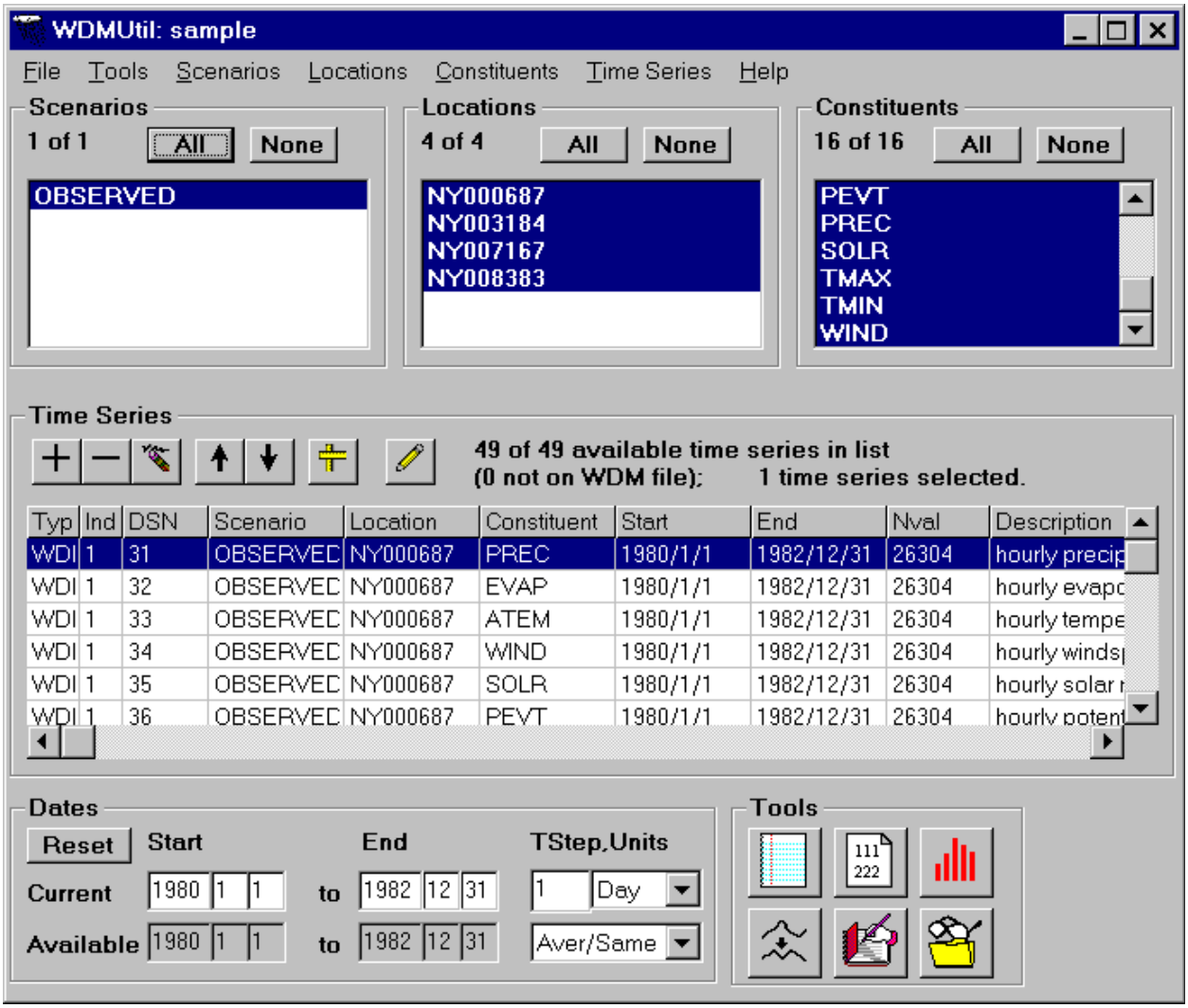
The first step in this lesson is to learn how to open an existing WDM file. (Lesson 9 provides an example of how to create a new WDM file.)

- Select the Open menu item from the File menu.
- Select the 'Sample' folder to move to the sample data directory.



- Select 'sample.wdm' to open the sample WDM file.

The WDM file is read and the main WDMUtil form is updated with the sample data as shown:



The Scenarios, Locations, and Constituents frames contain lists of all scenarios, locations, and constituents found on the data sets in the WDM file. When a WDM file is first opened, all of the items in the lists are selected.

The Time Series frame displays information about data sets in the time-series list. This frame also contains a toolbar for managing the contents of the time-series list. When a WDM file is first opened, all of the available data sets are added to the list, and the first data set in the list is selected.

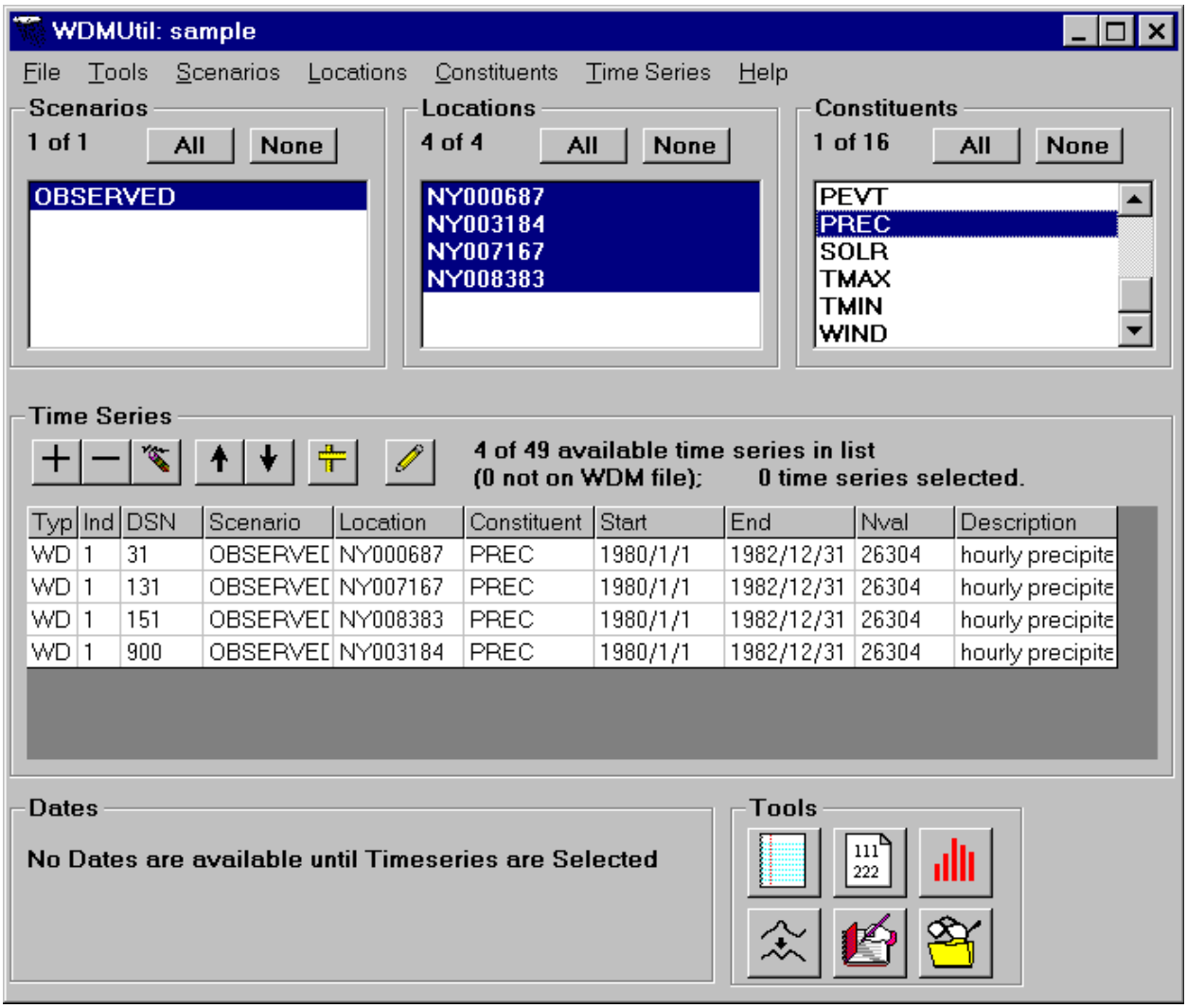
The Dates frame contains information about the range of dates available that is common to the currently selected data sets. For our selected data set, data are available from January 1, 1980, to December 31, 1982.

The Tools frame contains a toolbar that operates WDMUtil's analysis and computational tools. Later lessons will describe how to use these tools.

Between the Scenarios, Locations, and Constituents lists and the Time Series list, there is an invisible line, which may be used to resize these lists. This line is indicated by the mouse pointer changing to an up/down arrow when the pointer passes over the line. Resizing is performed by clicking on the line and dragging it up or down to adjust the list sizes as desired. Additionally, the entire main form of WDMUtil may be resized by dragging the edges of the form.

Resume this lesson by clearing the time-series list. This is done by clicking on the Clear  button in the Time Series frame (third from the left). The filtering capability of the Scenarios, Locations, and Constituents lists will now be demonstrated. If we were interested in finding which locations have precipitation data, we would do the following:

- Leave OBSERVED selected in the Scenarios list and all locations selected in the Locations list.
- Click on the PREC item in the Constituents list.
- Click on the Add  button in the Time Series frame.



Notice that only data sets which match the criteria specified in the Scenarios, Constituents, and Locations lists were added to the Time Series list and that all four locations do contain precipitation data. Also note that since none of the data sets are selected, no date information is available to display in the Dates frame.

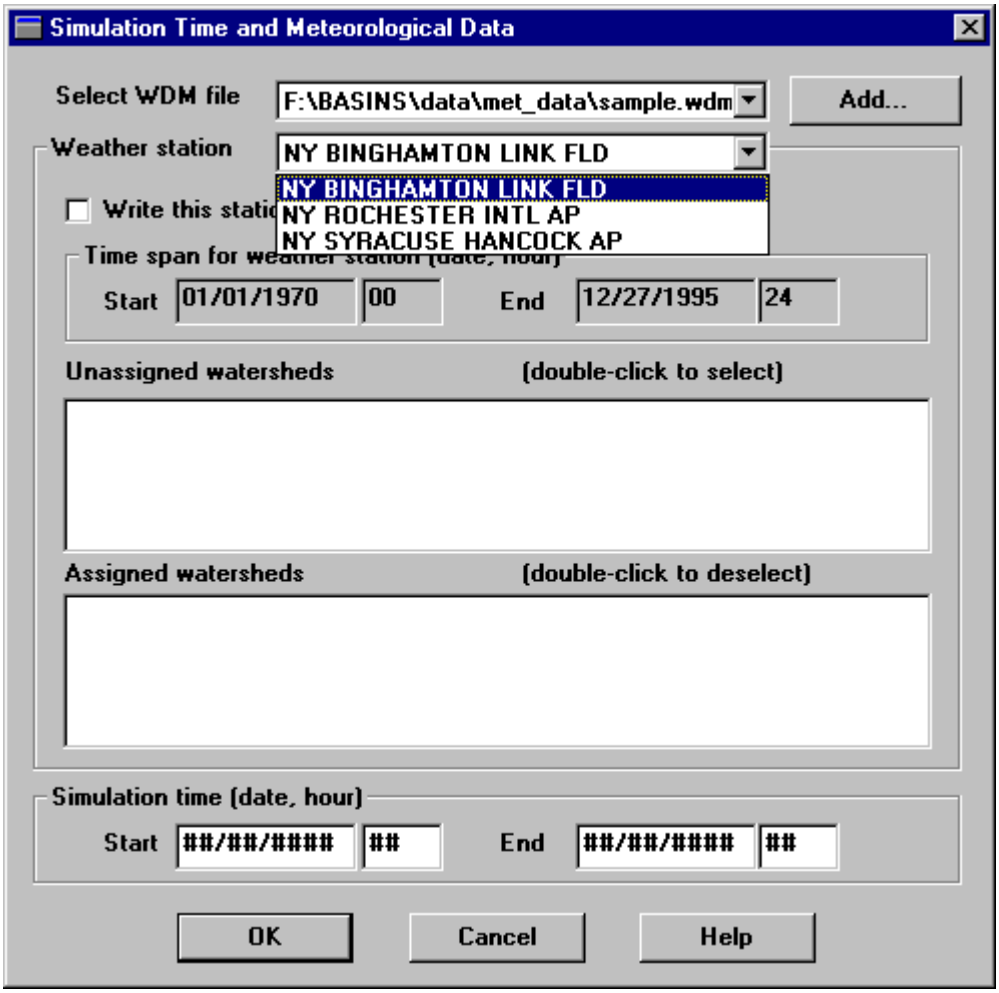
In a similar manner, we could have determined what data is available at a specific location by selecting the location from the Locations list and selecting all items in the Scenarios and Constituents list. Again clicking the Add button would add the matching data sets to the time-series list.

From here, either proceed on to Lesson 2 or exit the program. To exit WDMUtil, select the Exit menu item from the File menu or click on the X in the upper right corner of the main form.

2.2 Lesson 2: Accessing External Time Series

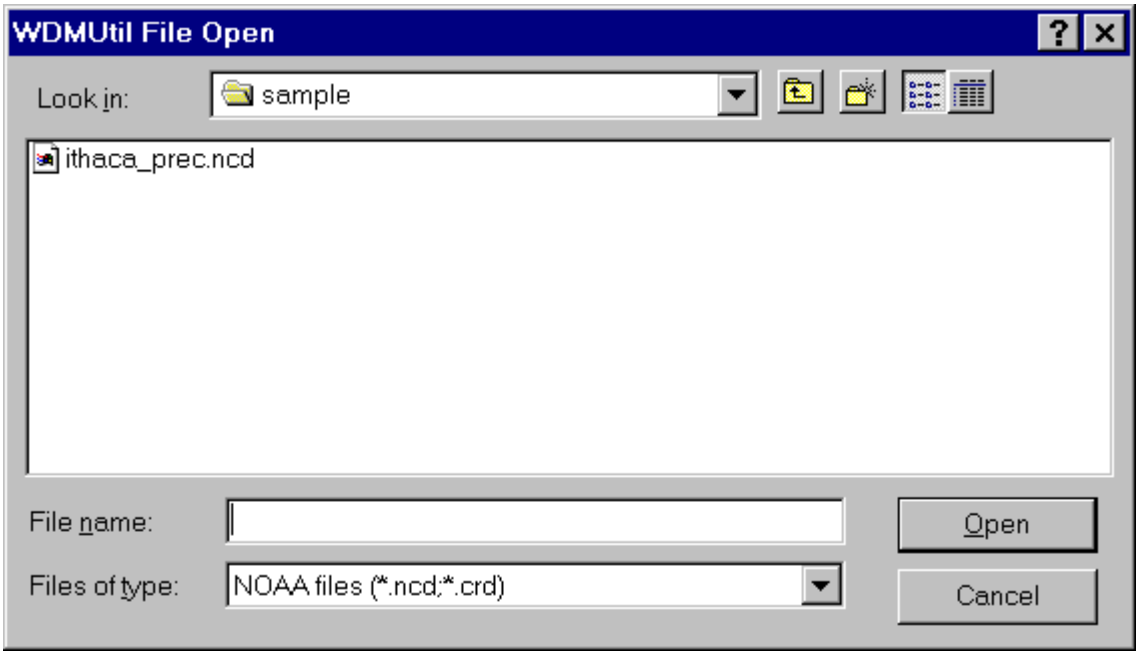
In this lesson, the method for reading data external to WDM into WDMUtil will be demonstrated. This example, in conjunction with Lesson 8, will demonstrate the most fundamental need addressed by WDMUtil, that is, taking data for a location not on a BASINS WDM file and adding it to a WDM file for use in BASINS.

For the sake of this example, we will assume we are trying to perform a watershed analysis in the Ithaca, NY area. If the original sample.wdm file were used for this application, the following stations would be available in the BASINS system:

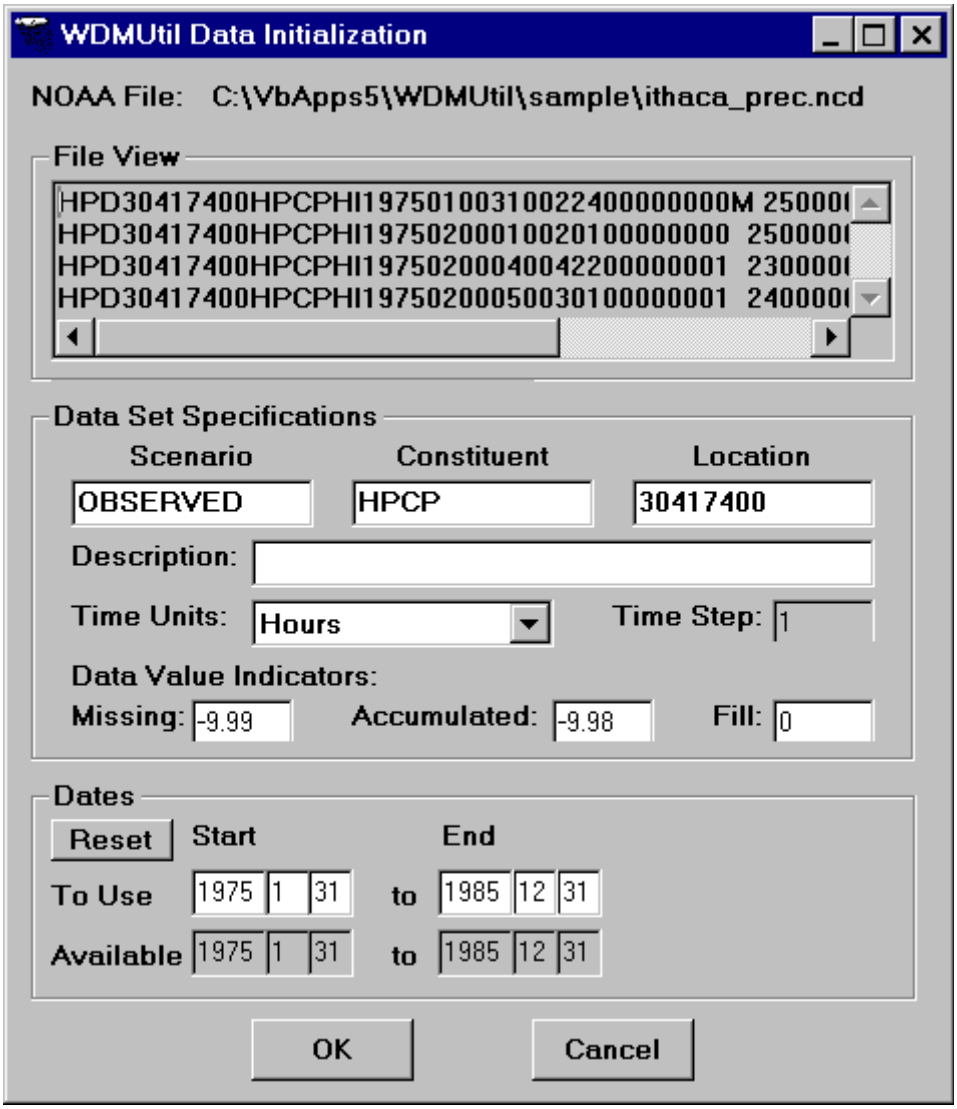


Lessons 2 and 8 will demonstrate the steps needed to add precipitation data local to the Ithaca area to the WDM file. They will also demonstrate how to update the BASINS information file so that the data from Ithaca is available in BASINS.

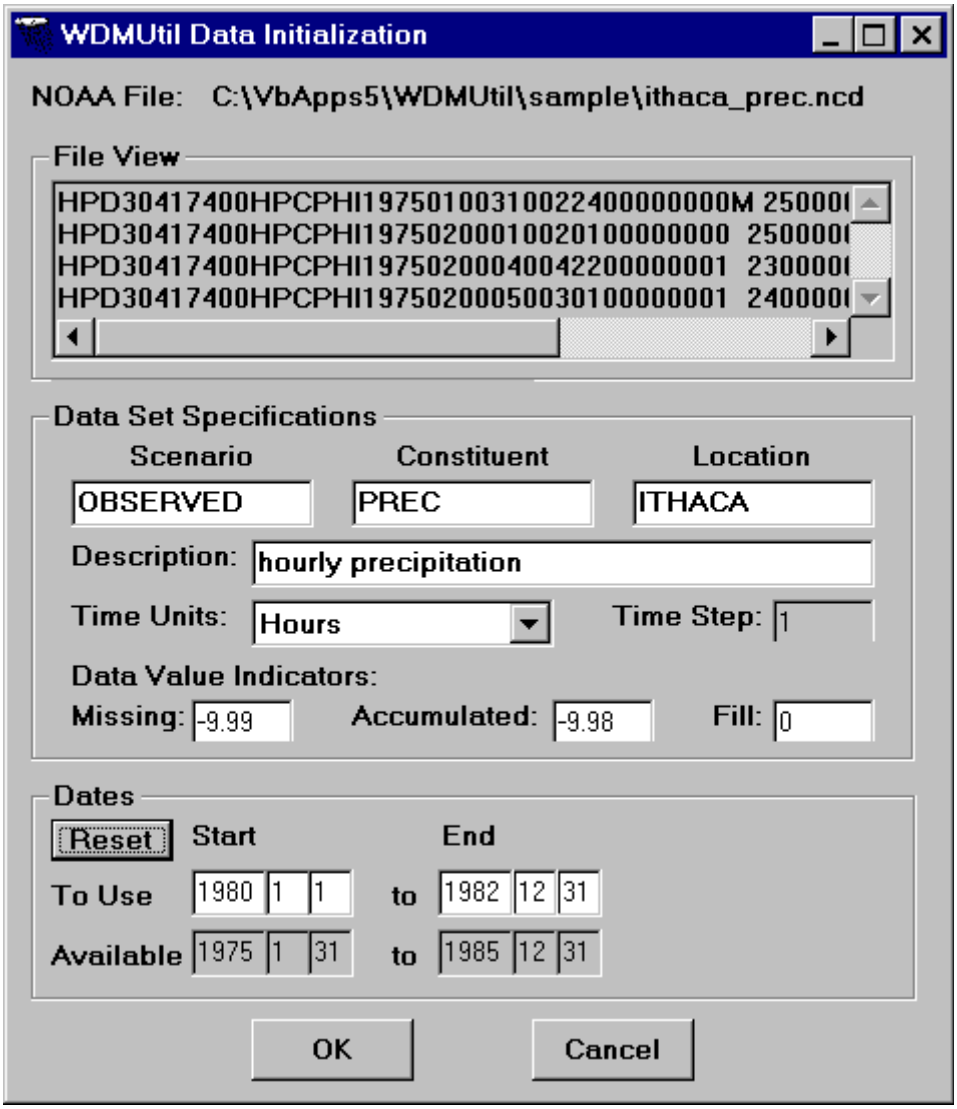
Begin by starting WDMUtil and opening the ‘sample.wdm’ file (see Lesson 1 for details on how to do this). Next, select the File:Open menu item.



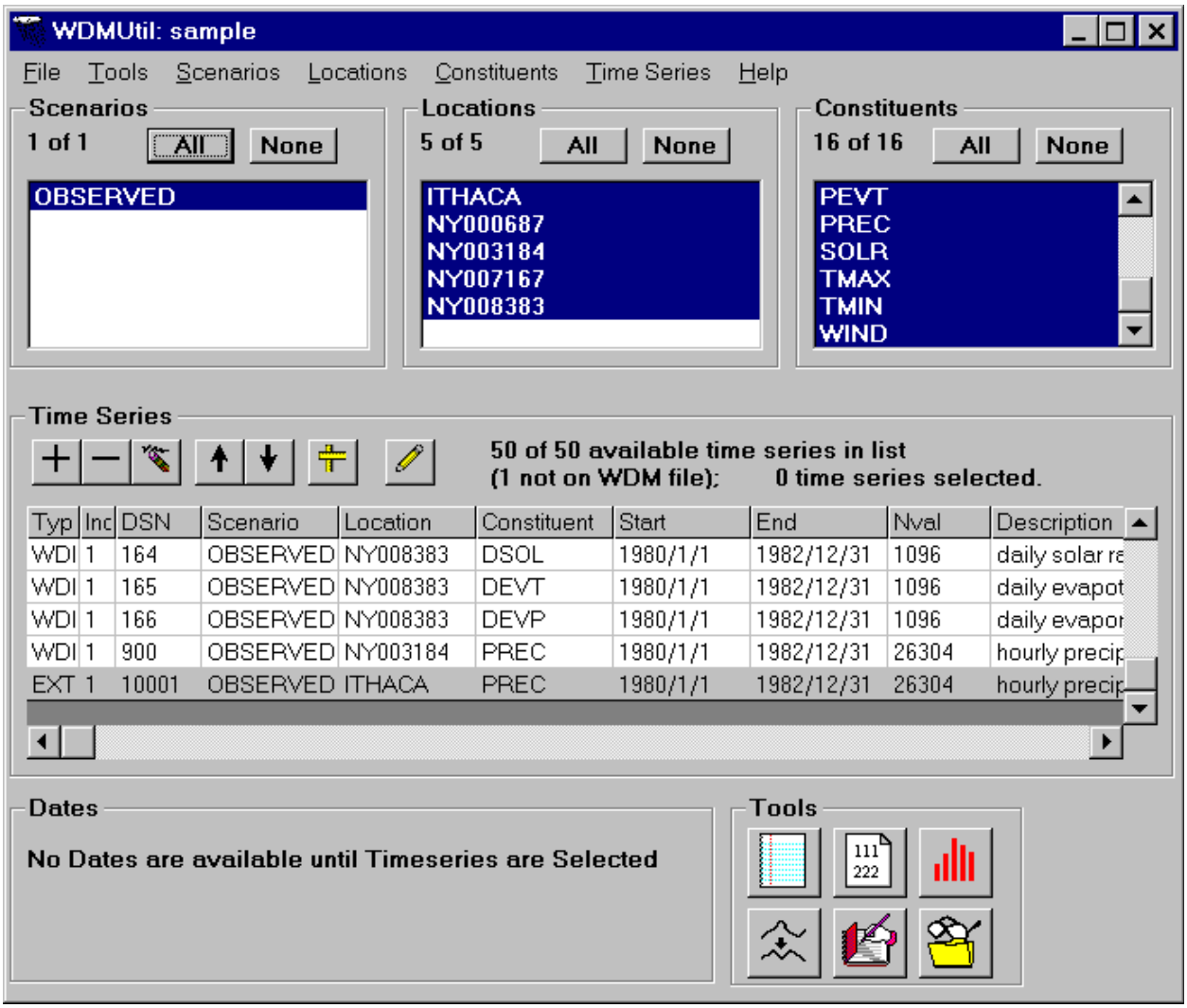
Note that the file open dialog now is prompting for a file in NCDC export format instead of a WDM file. Other external data formats are also available to be opened from this dialog by changing the Files of Type field at the bottom. For this exercise, select the NCDC export file named ithaca_prec.ncd. The WDMUtil Data Initialization form now appears.



Frames are available to view the top of the file, fill in needed data-set information, and specify the time period of data to be read. WDMUtil scans through the file and fills in as much default information as it can extract from the file. For this exercise, let's change the Constituent from HPCP to PREC to match the constituent name for precipitation used by the existing WDM data sets. Let's also change the Location value from a number (30417400) to a name, like ITHACA. Although not required, a description of the data set may be entered. Finally, since our existing WDM data only spans the years from 1980 to 1982, change the dates to read in only data for that time span. When all of these specifications have been made, the form should appear as follows:



Now click the ‘OK’ button to have WDMUtil read in the data. When it has finished reading the data, a message will be displayed indicating that the data was successfully read and added to the main WDMUtil form. The WDMUtil Data Initialization form will now be closed and the main WDMUtil form will be displayed.



Note that the main form has been updated to reflect the newly read data set. This includes adding ITHACA to the Locations list, updating the count of both available time series and time series not on WDM file displayed in the Time Series frame, and adding the new data set to the time-series list. Note that the new data set has a Type (1st column in time-series list) of EXT (for external) instead of WDM. It is also displayed in a color different from the WDM data sets to indicate that it has not been saved to the WDM file. This new data set is now available to WDMUtil, in the same manner as existing WDM data sets, for analyses and computations. However, it is not yet saved on the WDM file.

To learn how to write this new data to the WDM file, proceed to Lesson 8. Otherwise, close WDMUtil and click the ‘Yes’ button when asked if you are sure you want to exit since you have data which has not been saved to WDM.

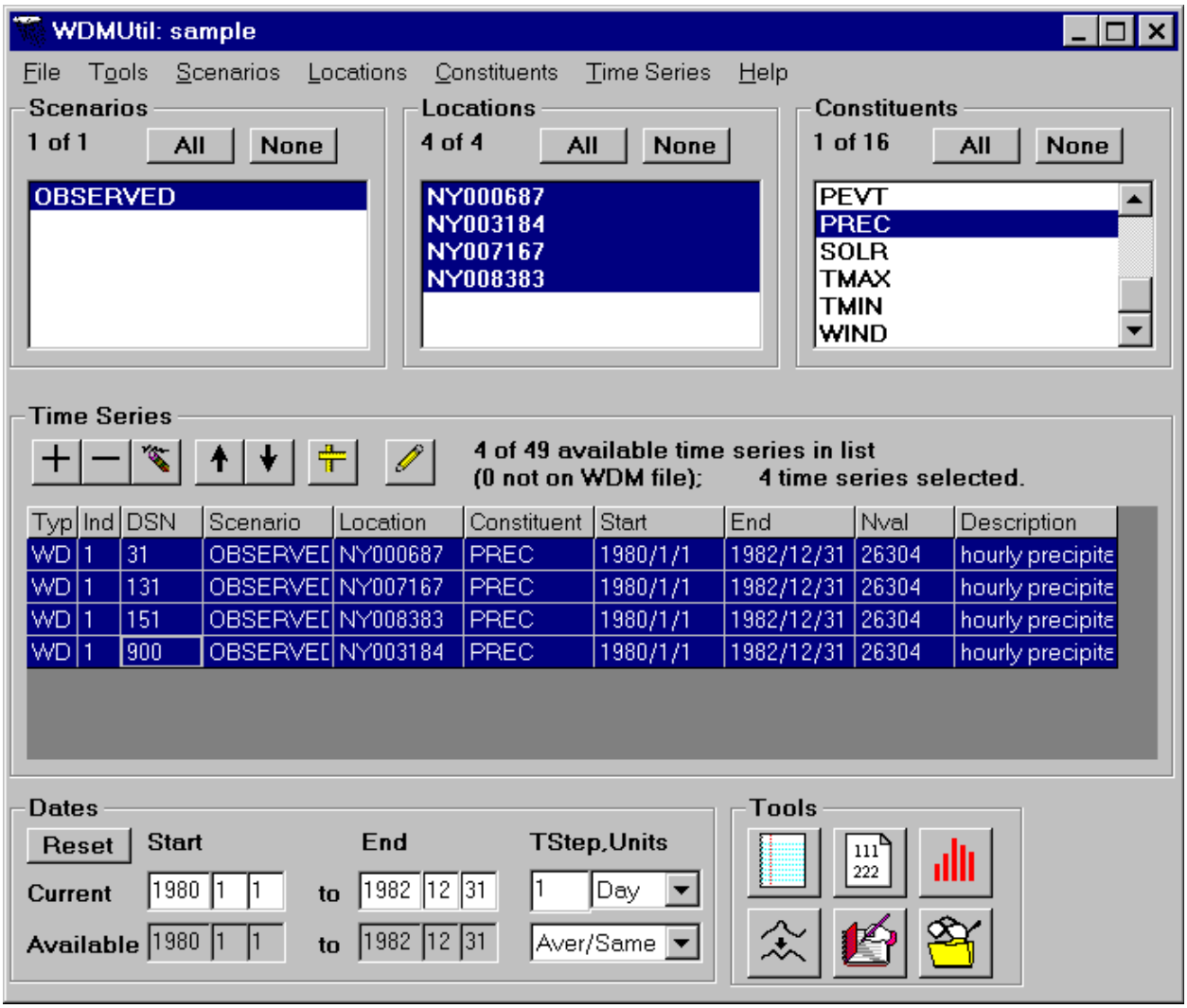
2.3 Lesson 3: Summarizing Data

In this lesson the method for summarizing data and reporting missing, accumulated, or faulty values will be demonstrated. It is common to find missing or invalid values in recorded meteorological data. The Summarize tool helps a user to locate such values and determine their frequency.

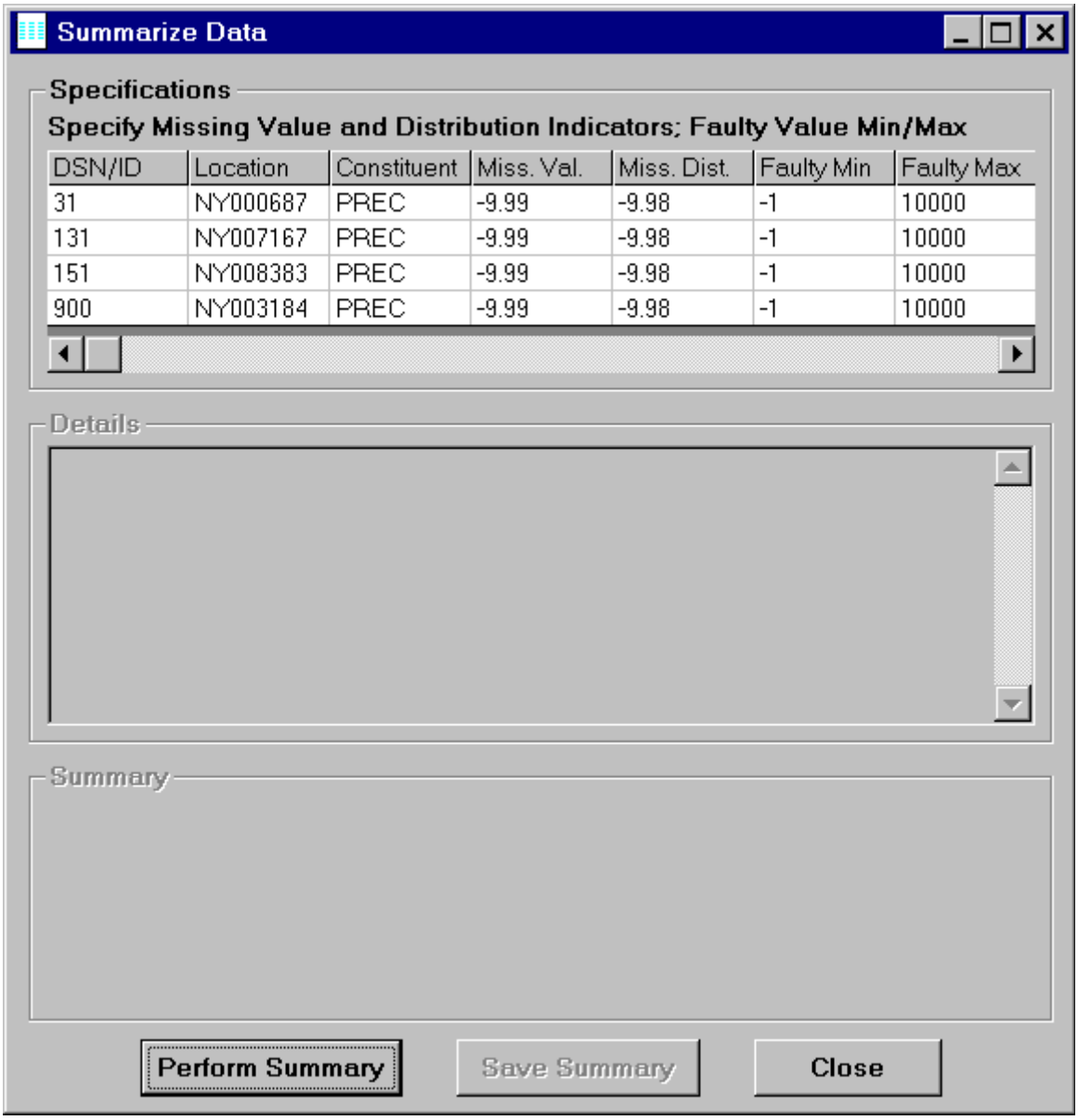
If you are starting from scratch, start WDMUtil and open the 'sample.wdm' file, (see Lesson 1 for how to do this).

In this lesson, missing data in precipitation data sets will be summarized. To select only precipitation data sets, do the following:

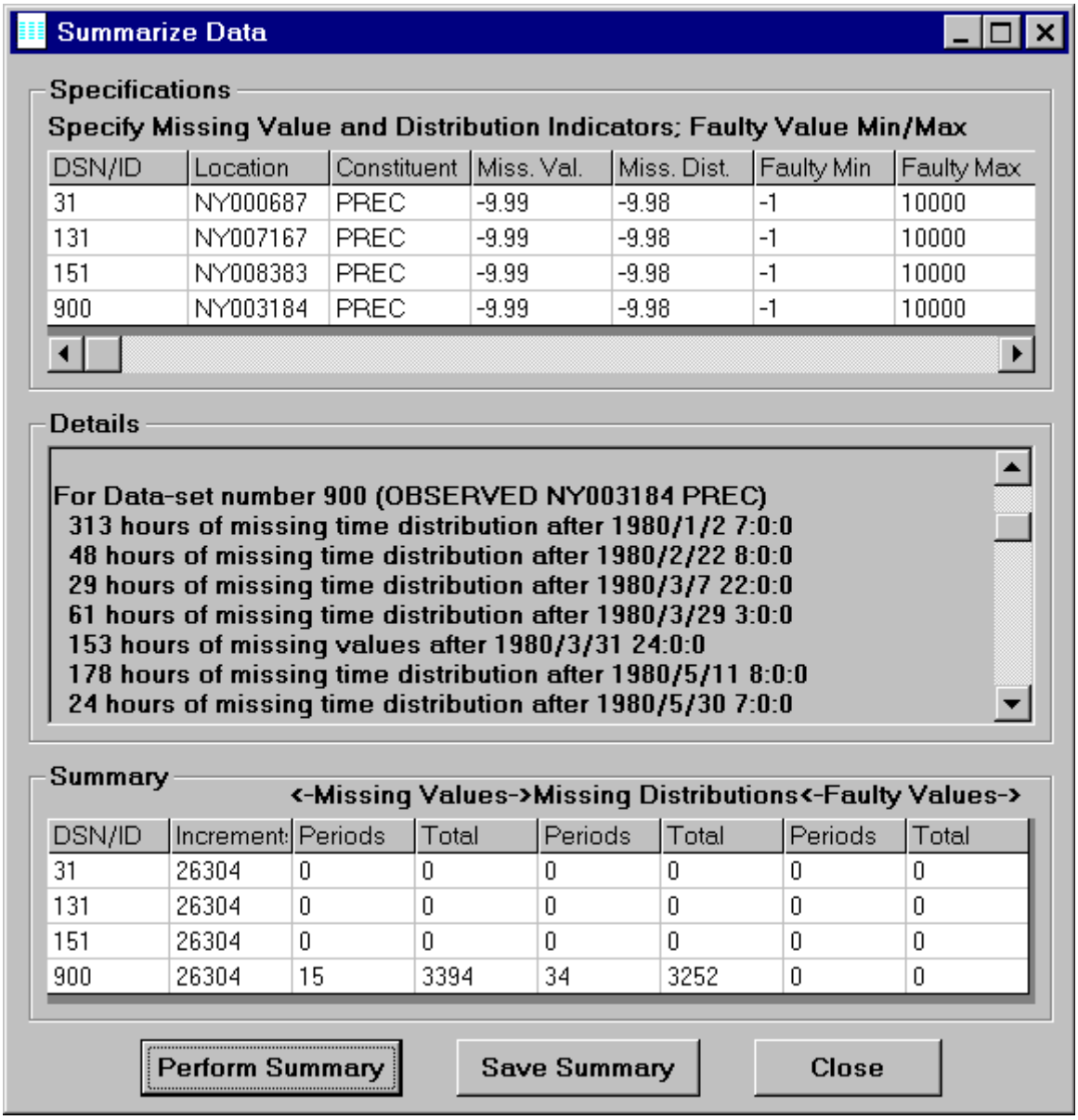
- Clear the time-series list by clicking the Clear  button.
- Leave all Scenarios and Locations selected.
- Select only the PREC item from the Constituent list.
- Add the data sets that match these criteria by clicking the Add  button.
- Select the four data sets in the time-series list as shown in the following figure. (If Lesson 8 has already been performed, data-set number 600 will also appear in the list. You may want to leave it unselected so that your ensuing screens will match the documentation).



Clicking the Summarize  button in the Tools frame will cause the Summary of Missing Data form to appear. For the data used in this exercise, it is known that our missing value indicator is -9.99 and our missing time distribution indicator is -9.98. Modify the values in the respective columns to these values as shown in the following picture. Since this is precipitation data, the faulty min (-1) and faulty max (10000) values are acceptable.



Now click on the 'Perform Summary' button at the bottom of the form. Note from the Summary frame that none of the first three data sets have any missing data, but the fourth one (number 900) does have significant amounts of missing values and distributions. To see the detailed list of these missing data, scroll down in the report displayed in the Details frame.



If desired, the ‘Save Summary’ button may be used to output the contents of the Details and Summary frames to a file for future viewing or printing.

The following lesson (Time-Series Listing and Editing) will demonstrate how to list data sets with missing values along-side data sets with good values and how to edit these missing values.

2.4 Lesson 4: Time-Series Listing and Editing

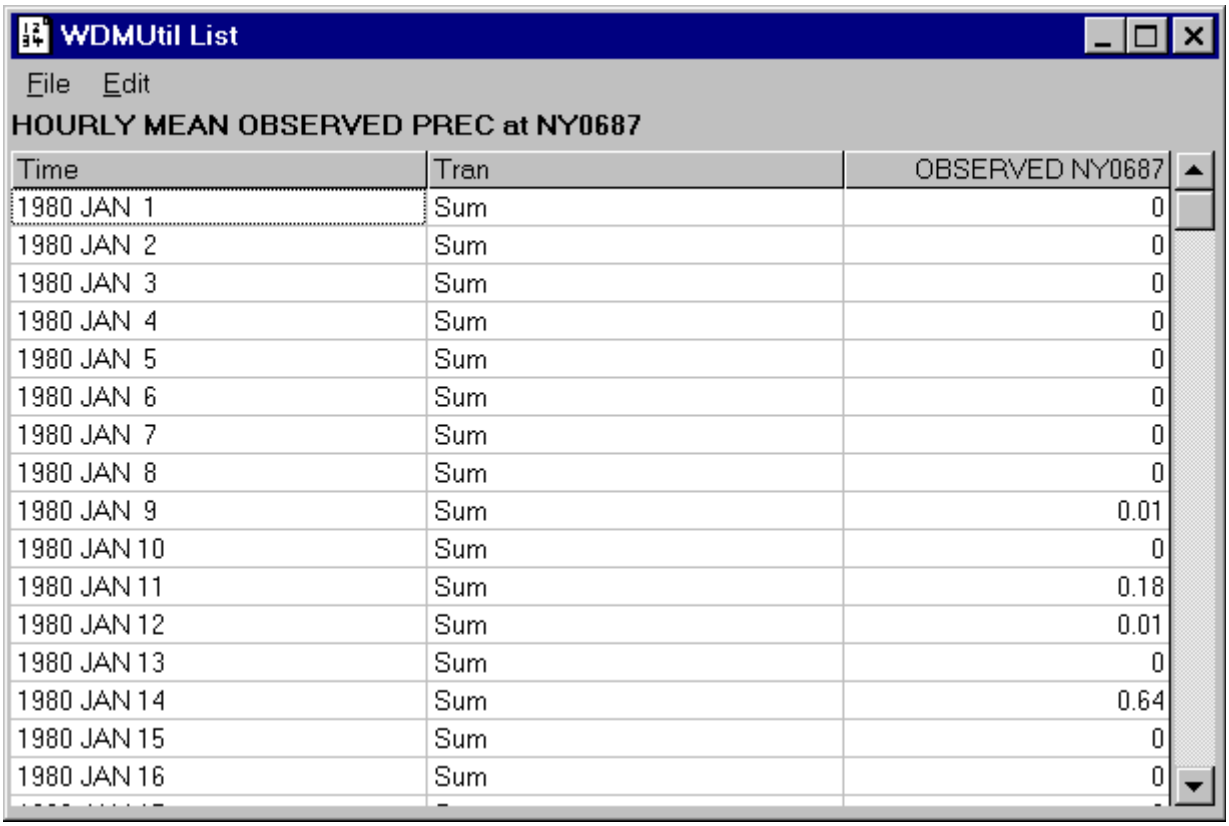
In this lesson, some of WDMUtil's time-series listing capabilities will be demonstrated. The listing tool is useful for performing quality assurance checks on data. The summary capabilities, demonstrated in this lesson, enhance the list tool's ability to assist in quality assurance. Additionally, the ability to edit listed time-series values will be demonstrated. A portion of the missing data identified in Lesson 3 will be listed and amended.

If not already running WDMUtil with the sample data, start WDMUtil and open the 'sample.wdm' file (see Lesson 1 to learn how to do this). We will list the observed precipitation data at NY000687, or data-set number 31. (If this is not the first data set in the Time Series list, clear the list using the Clear  button, select all items in the Scenario, Location, and Constituent lists, and then add all the data sets using the Add  button).

Select the data set at the top of the Time Series list (31), which is hourly precipitation. However, as a quality assurance check without looking at every hourly value, we will list the daily sums of this data set's values to look for any abnormal daily totals.

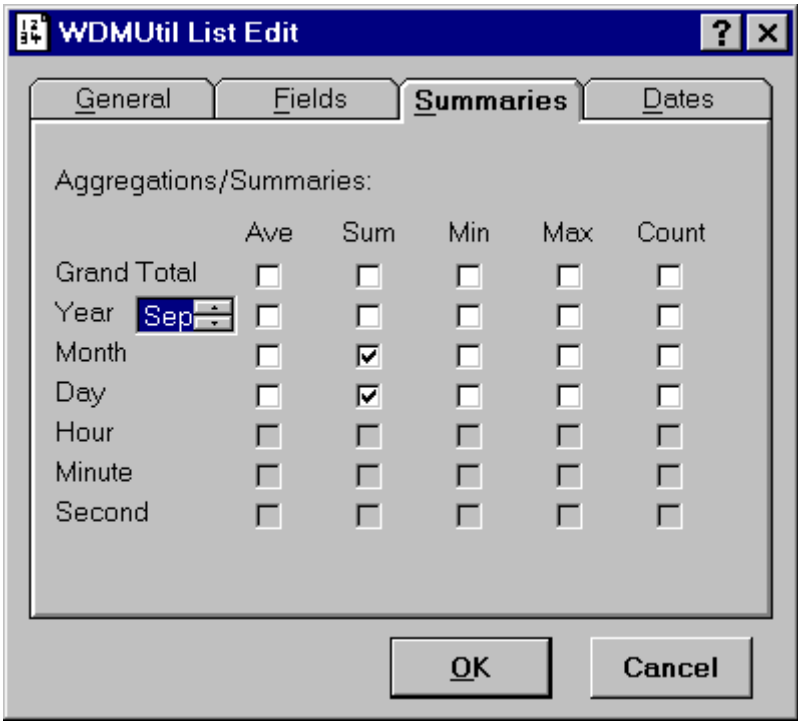
- Leave the TStep and Units in the Dates frame at 1 and Day, respectively.
- Select the Sum/Div item in the list below TStep and Units.
- Click the List  button in the Tools frame.

A form containing a daily listing of the hourly precipitation values will appear.

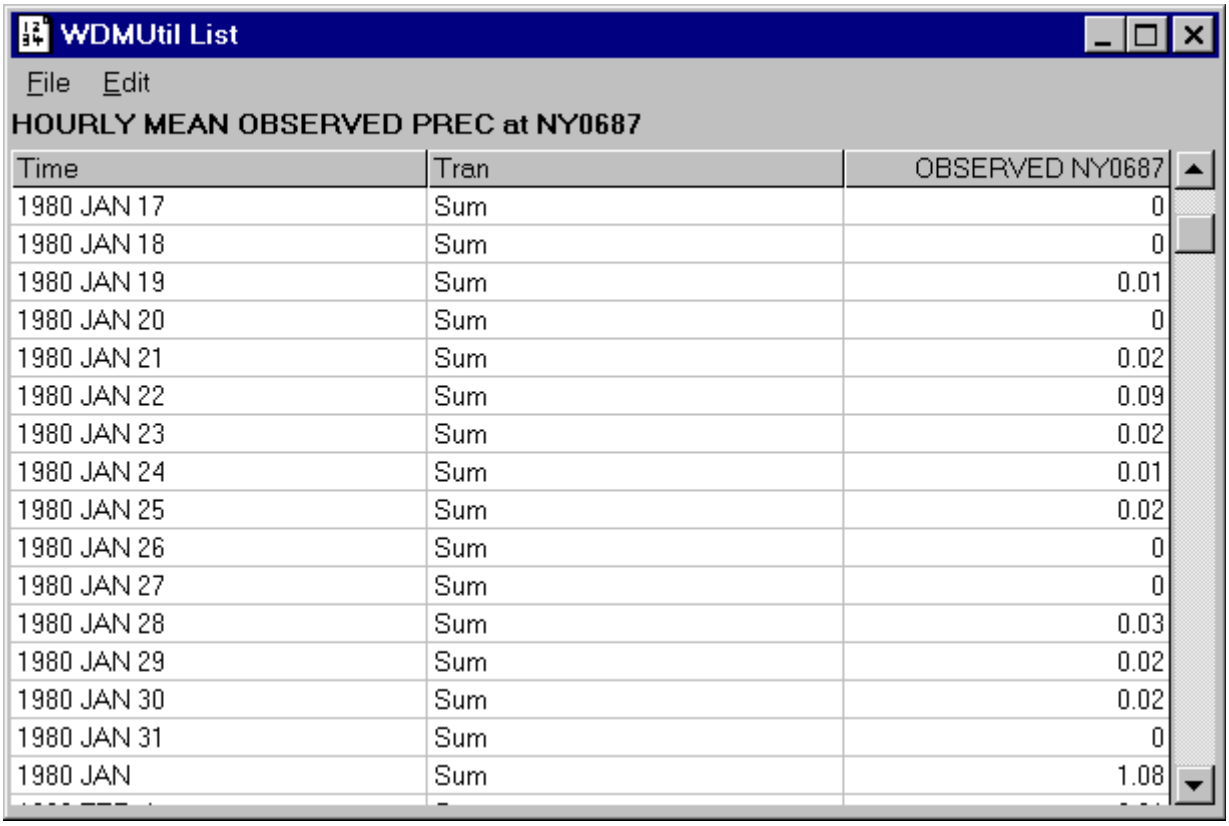


Time	Tran	OBSERVED NY0687
1980 JAN 1	Sum	0
1980 JAN 2	Sum	0
1980 JAN 3	Sum	0
1980 JAN 4	Sum	0
1980 JAN 5	Sum	0
1980 JAN 6	Sum	0
1980 JAN 7	Sum	0
1980 JAN 8	Sum	0
1980 JAN 9	Sum	0.01
1980 JAN 10	Sum	0
1980 JAN 11	Sum	0.18
1980 JAN 12	Sum	0.01
1980 JAN 13	Sum	0
1980 JAN 14	Sum	0.64
1980 JAN 15	Sum	0
1980 JAN 16	Sum	0

As an additional quality assurance check, we will now add monthly totals to our existing list. Select the Summaries item from the Edit menu. A form showing the current summaries being listed and others that may be listed is displayed. To add a monthly sum to the current listing, click the box in the Sum column and the Month row so that the form appears as shown below.



Now click the ‘OK’ button to close the form and rebuild the listing. The listing will now display an additional row at the end of each month with the sum of all values for that month.



WDMUtil List

File Edit

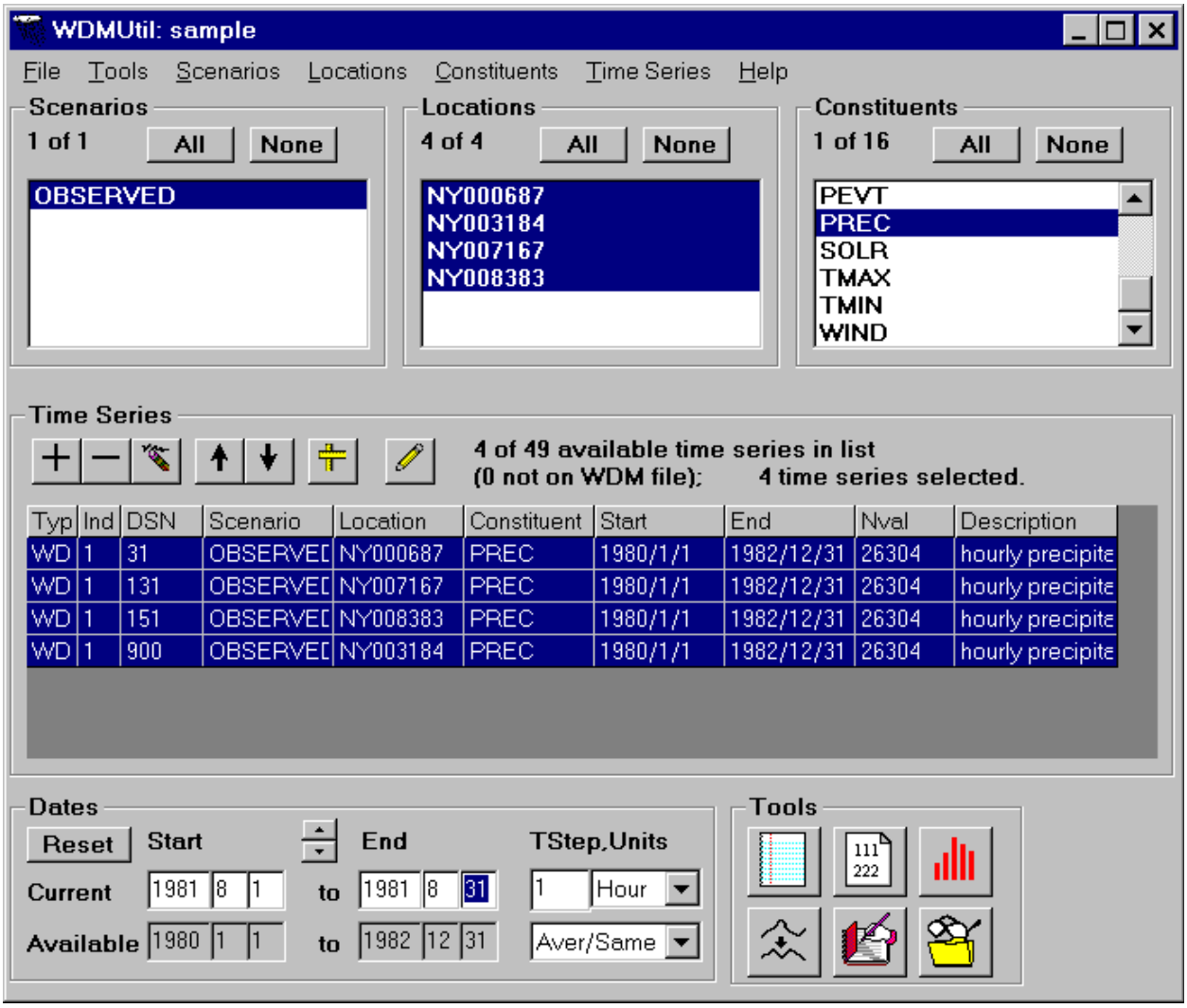
HOURLY MEAN OBSERVED PREC at NY0687

Time	Tran	OBSERVED NY0687
1980 JAN 17	Sum	0
1980 JAN 18	Sum	0
1980 JAN 19	Sum	0.01
1980 JAN 20	Sum	0
1980 JAN 21	Sum	0.02
1980 JAN 22	Sum	0.09
1980 JAN 23	Sum	0.02
1980 JAN 24	Sum	0.01
1980 JAN 25	Sum	0.02
1980 JAN 26	Sum	0
1980 JAN 27	Sum	0
1980 JAN 28	Sum	0.03
1980 JAN 29	Sum	0.02
1980 JAN 30	Sum	0.02
1980 JAN 31	Sum	0
1980 JAN	Sum	1.08

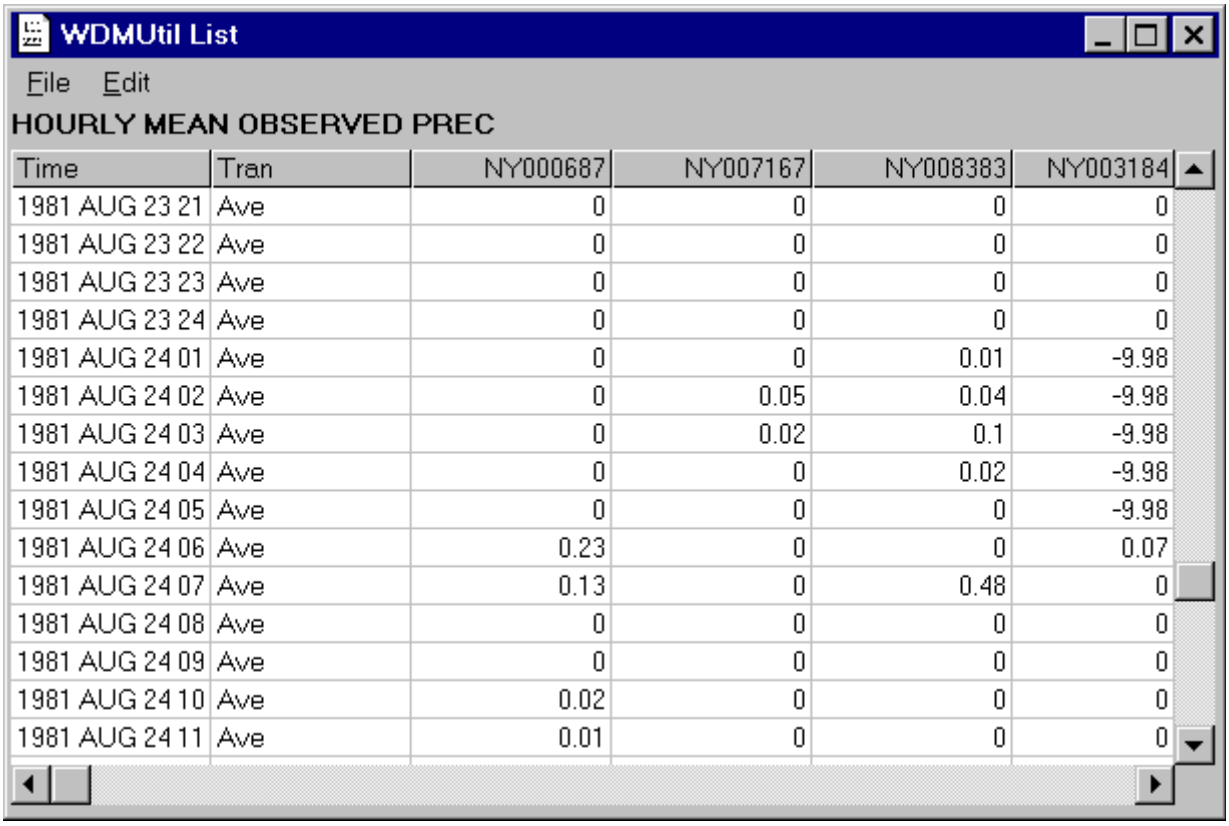
The List tool may also be used to edit missing or faulty data values. To demonstrate this functionality:

- Close the List form (click the X button in the upper right corner or select the File:Close menu item) and return to the main form.
- Remove all data sets from the time-series list by clicking the Clear button.
- Click only the PREC item in the Constituents list.
- Add the matching data sets by clicking the Add button.
- Click on all of the items in the time-series list to select them for listing. (If you have already performed lesson 8 and saved the ITHACA PRECipitation data to the WDM file, you may wish to not select it so that your results will match the ensuing figures).

We will be correcting some missing data on data-set number 900 during the month of August in 1981. Set the start and end dates as shown below and also set the time units to hours.



Click the List button to generate the time-series listing and then scroll down to August 24th.



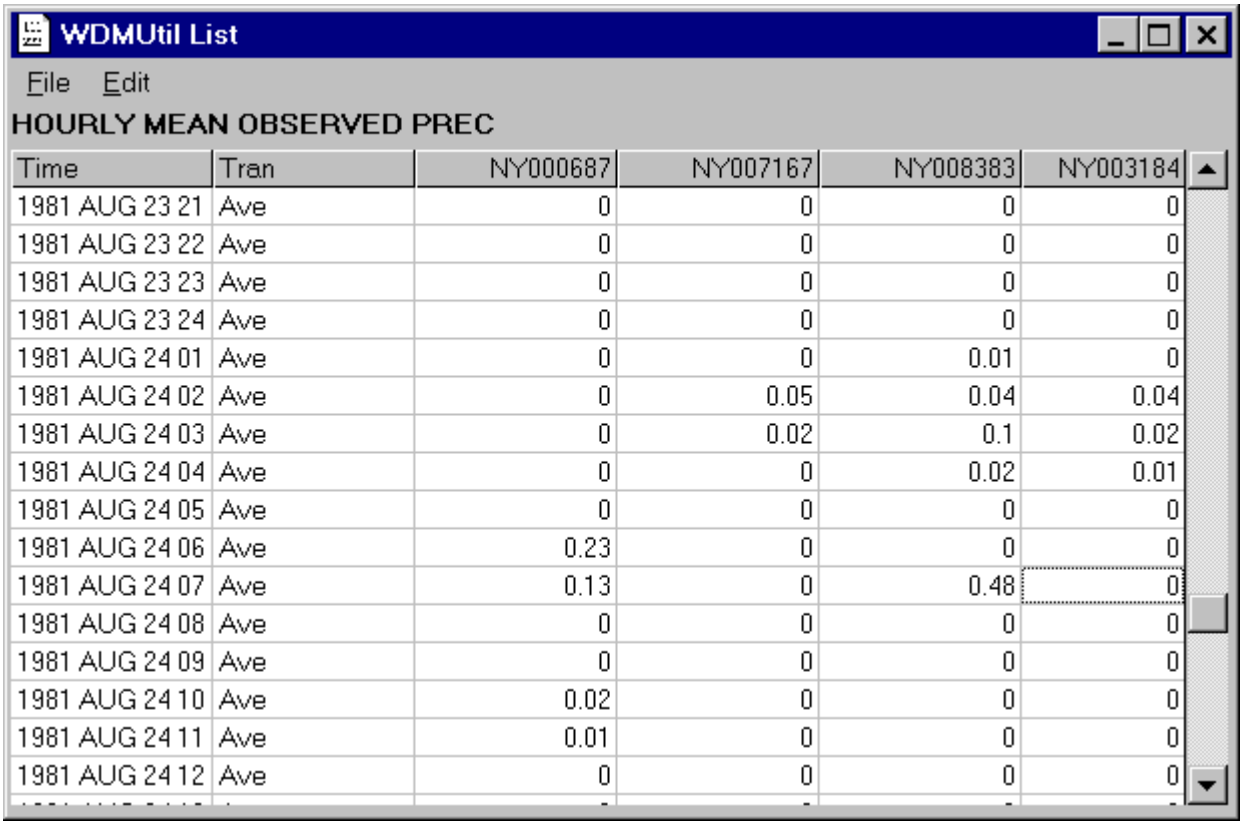
WDMUtil List

File Edit

HOURLY MEAN OBSERVED PREC

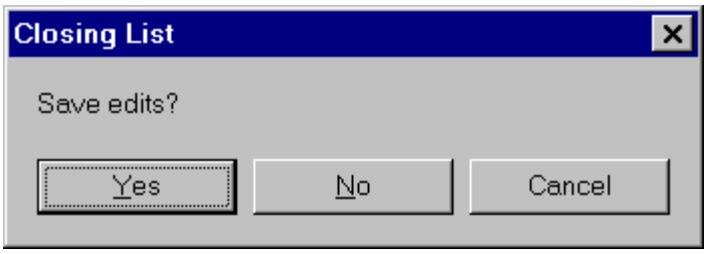
Time	Tran	NY000687	NY007167	NY008383	NY003184
1981 AUG 23 21	Ave	0	0	0	0
1981 AUG 23 22	Ave	0	0	0	0
1981 AUG 23 23	Ave	0	0	0	0
1981 AUG 23 24	Ave	0	0	0	0
1981 AUG 24 01	Ave	0	0	0.01	-9.98
1981 AUG 24 02	Ave	0	0.05	0.04	-9.98
1981 AUG 24 03	Ave	0	0.02	0.1	-9.98
1981 AUG 24 04	Ave	0	0	0.02	-9.98
1981 AUG 24 05	Ave	0	0	0	-9.98
1981 AUG 24 06	Ave	0.23	0	0	0.07
1981 AUG 24 07	Ave	0.13	0	0.48	0
1981 AUG 24 08	Ave	0	0	0	0
1981 AUG 24 09	Ave	0	0	0	0
1981 AUG 24 10	Ave	0.02	0	0	0
1981 AUG 24 11	Ave	0.01	0	0	0

Note that hours 1 through 6 of the 24th for the NY003184 location contain an accumulated value of 0.07. This means that the reading measured 0.07 at hour 6, but the event(s) could have occurred any time during the past 6 hours. It is possible to enter estimated values for this period based on the values of the nearby locations listed along side NY003184. Click on the first missing value and then enter an estimated value. Press the down arrow key to move to the next missing data value and continue filling in missing values as desired.



Time	Tran	NY000687	NY007167	NY008383	NY003184
1981 AUG 23 21	Ave	0	0	0	0
1981 AUG 23 22	Ave	0	0	0	0
1981 AUG 23 23	Ave	0	0	0	0
1981 AUG 23 24	Ave	0	0	0	0
1981 AUG 24 01	Ave	0	0	0.01	0
1981 AUG 24 02	Ave	0	0.05	0.04	0.04
1981 AUG 24 03	Ave	0	0.02	0.1	0.02
1981 AUG 24 04	Ave	0	0	0.02	0.01
1981 AUG 24 05	Ave	0	0	0	0
1981 AUG 24 06	Ave	0.23	0	0	0
1981 AUG 24 07	Ave	0.13	0	0.48	0
1981 AUG 24 08	Ave	0	0	0	0
1981 AUG 24 09	Ave	0	0	0	0
1981 AUG 24 10	Ave	0.02	0	0	0
1981 AUG 24 11	Ave	0.01	0	0	0
1981 AUG 24 12	Ave	0	0	0	0

Since we are just demonstrating this feature, it is not imperative to edit all of the missing values. Now close the List form. Since values were edited, you are now prompted to indicate whether or not you want to save the values.



Click the ‘No’ button since we are not concerned with actually saving the edited values.

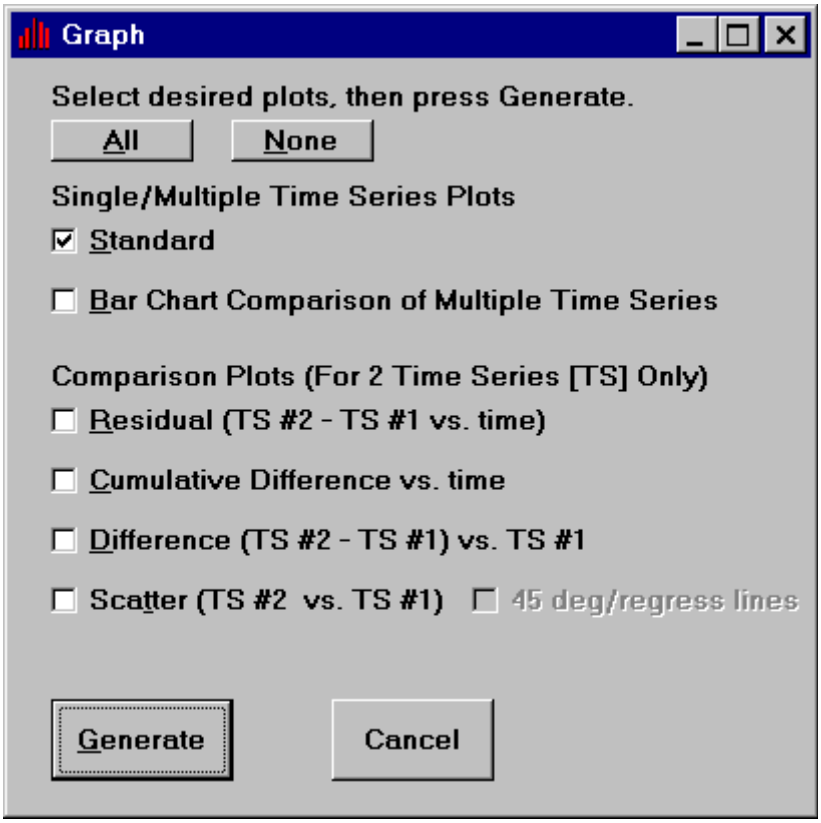
2.5 Lesson 5: Time-Series Graphics

In this lesson, some of WDMUtil's time-series graphics capabilities will be demonstrated. The Graph tool provides a suite of plots for graphically viewing time-series data. This lesson will use a standard time-series plot to compare two related data set's values over time.

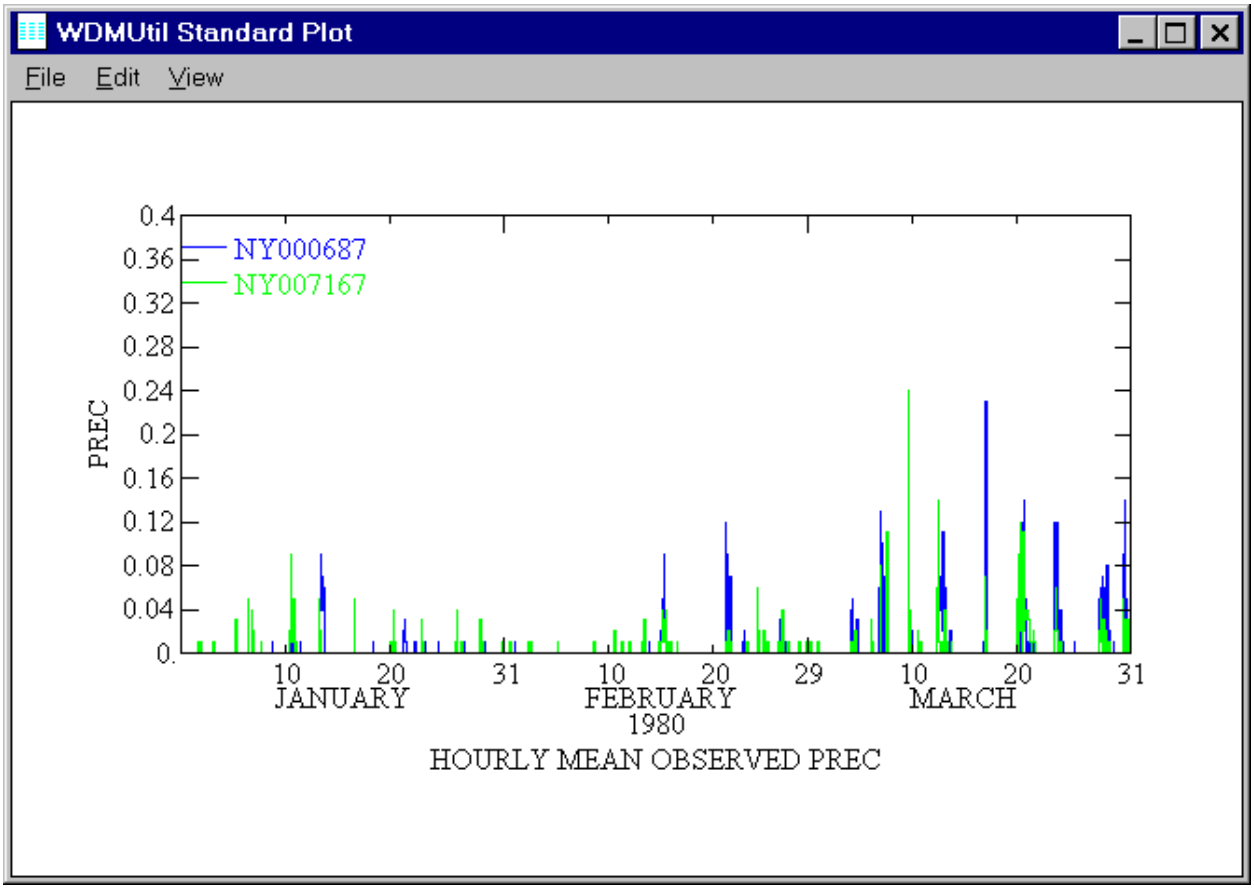
If not already running WDMUtil with the sample data, start WDMUtil and open the 'sample.wdm' file (see Lesson 1 to learn how to do this). We will plot the first two hourly precipitation (PREC) data sets in the Time Series list, data-set numbers 31 and 131. (If these data sets are not in the Time Series list, clear the list using the Clear  button, select all items in the Scenario, Location, and Constituent lists, and then add all the data sets using the Add  button).

- Select the first data set (number 31) at the top of the Time Series list.
- Scroll down to the next PREC data set (number 131 under the DSN column) and select it.
- Since this is hourly data, we will only plot the first three months, so change the ending year to 1980 and the ending month to 3 in the Dates frame.
- Select Hour from the Units list instead of Day.
- Click the Graph  button in the Tools frame.

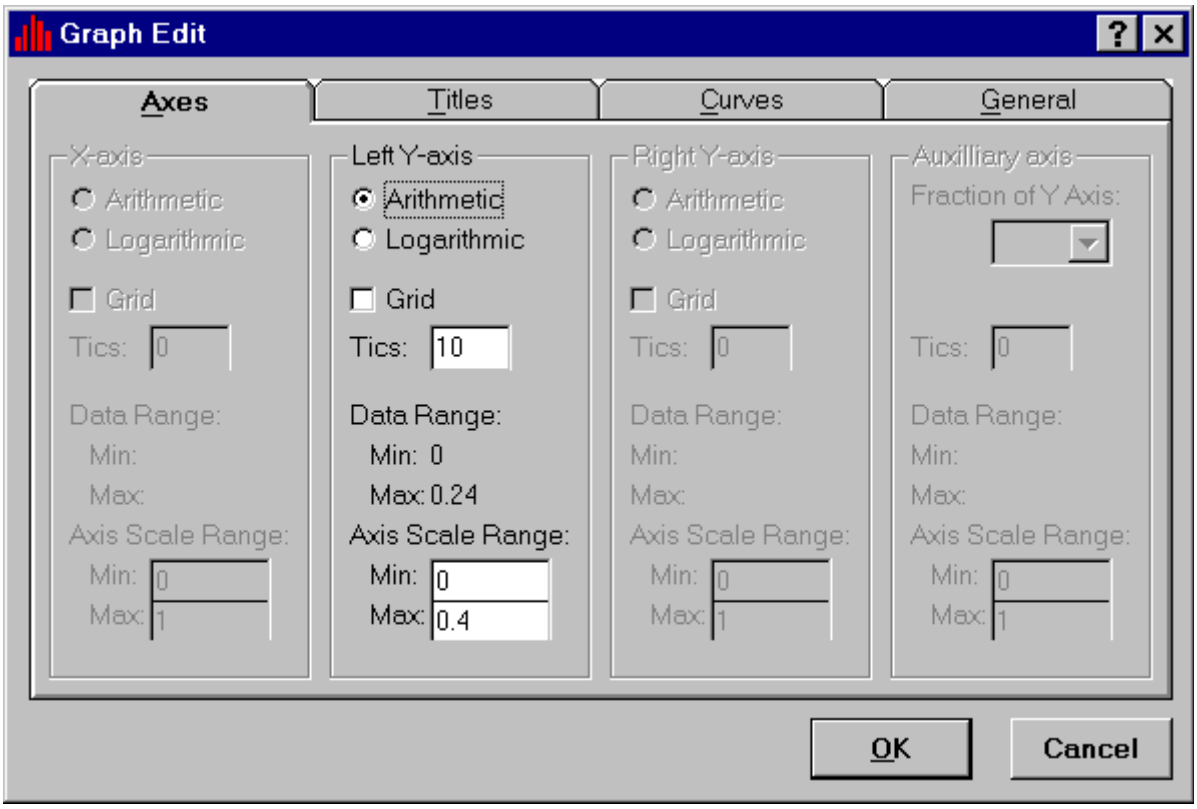
A form displaying the available graphs will appear.



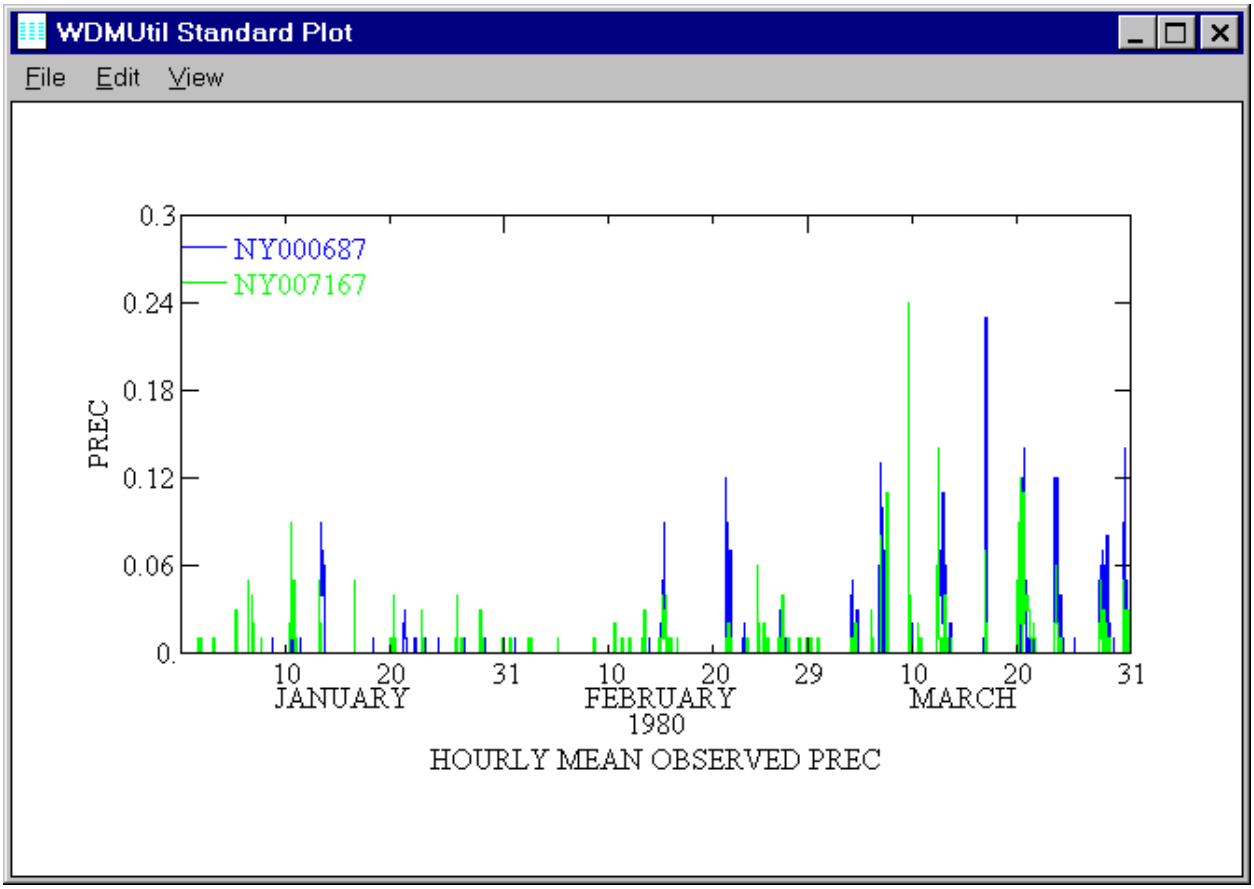
For this lesson, we will only be generating the Standard time-series plot. Click the ‘Generate’ button to create the plot.



From this point, most of the items on the plot may be customized as desired. This is done through the use of the Edit menu, which has options for modifying Axes, Titles, Curves, General information, and Fonts. Besides using the Edit menu, many of these modifications may be initiated by clicking on the item to be changed. For example, click on either the top or bottom X-axis and the Graph Edit form will appear with the Axes tab at the front.



To have the curves use more of the available plotting space, change the Axis Scale Range Max value from 0.4 to 0.3. Also change the number of tics from 10 to 5. Now click the ‘OK’ button and the plot will be redrawn with the modified Y-axis scale.

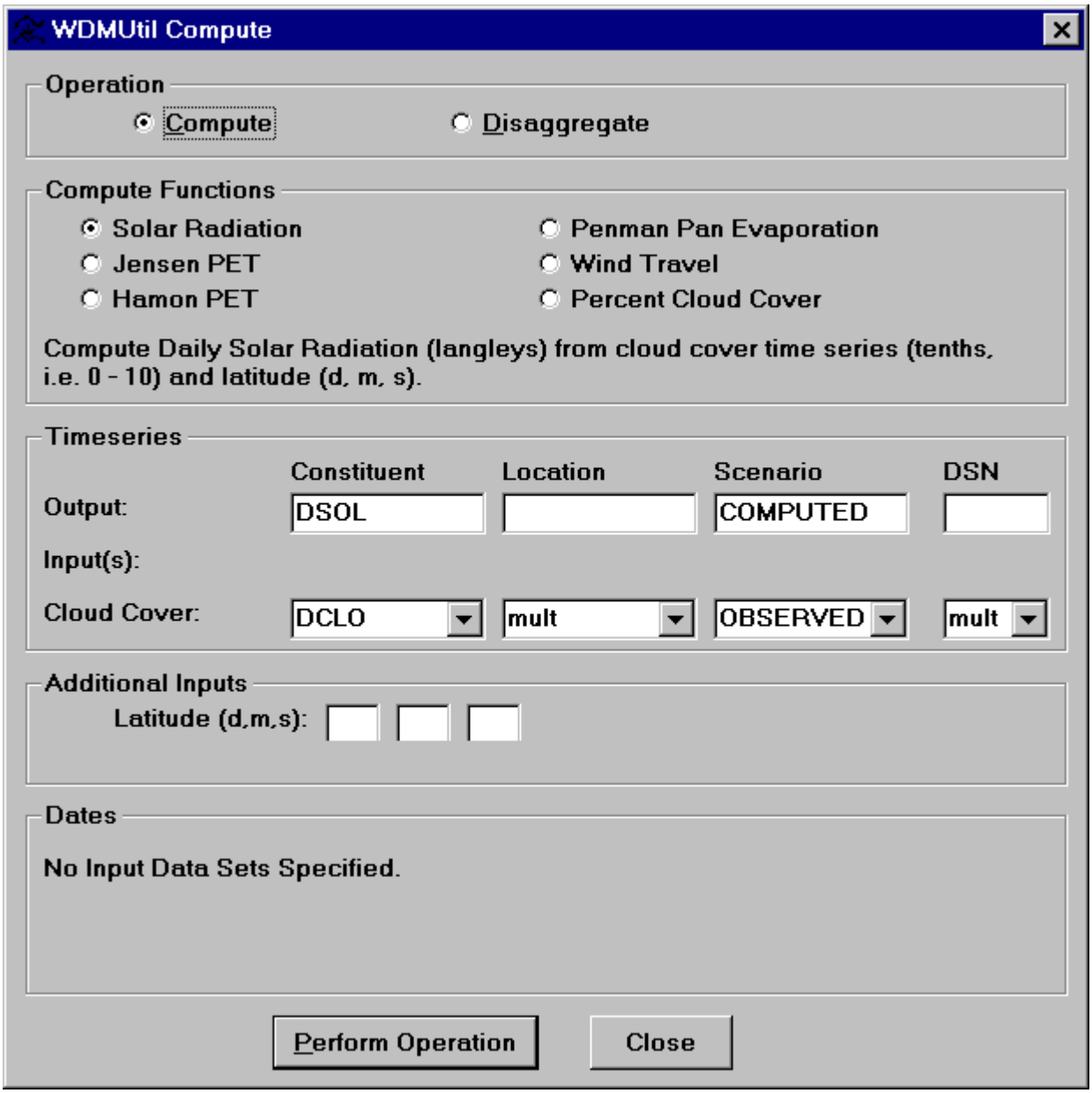


Close the Plot form by clicking the 'X' button in the upper right corner (or by selecting the File:Close menu item). Also close the Graph form by clicking the 'Cancel' button.

2.6 Lesson 6: Computing New Time Series

In this lesson, the ability to compute new meteorological time-series data from existing data will be demonstrated. When developing a BASINS study for a local area that is not near an existing BASINS WDM location, it is common to have a limited set of meteorological data available. The Compute functions provide alternative methods for developing the meteorological constituents needed for use in BASINS.

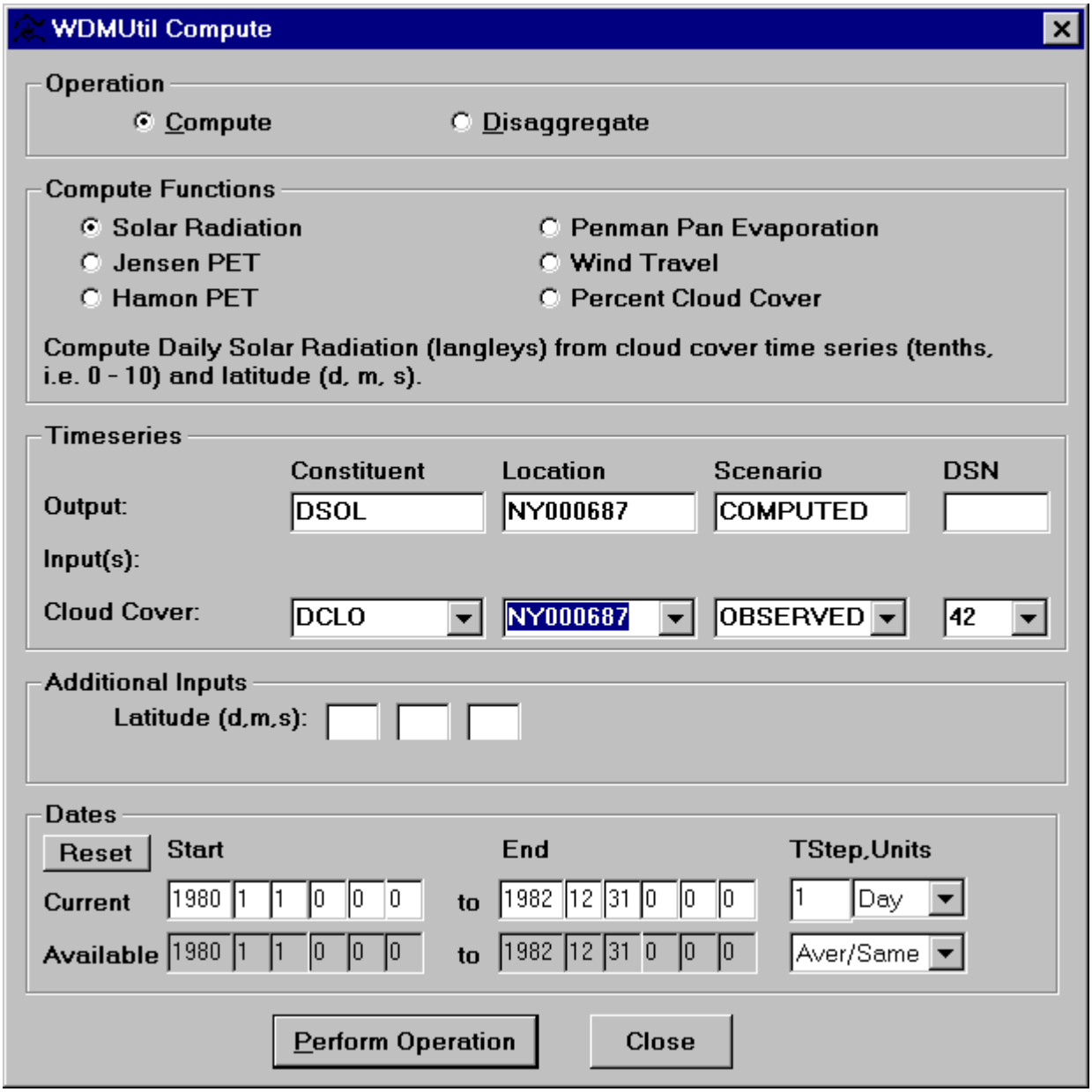
If not already running WDMUtil with the sample data, start WDMUtil and open the ‘sample.wdm’ file (see Lesson 1 to learn how to do this). Click on the Compute  button in the Tools frame and the Compute form will be displayed.



In this lesson we will demonstrate how to compute Solar Radiation time-series data. The Solar Radiation option should already be selected in the Compute Functions frame as the operation to perform. The needed input and output data sets are specified in the Timeseries frame. As indicated, the input data needed to compute solar radiation is Cloud Cover. The pull-down list next to the Cloud Cover label contains all of the constituent types from the available data sets. Since WDMUtil knows that daily cloud cover data is needed to compute daily solar radiation, it has defaulted the list to the DCLO (daily cloud cover) item.

The Location and Scenario lists have been updated to contain only items from data sets that are of daily cloud cover type. The ‘mult’ displayed in the Location column indicates that there is more than one

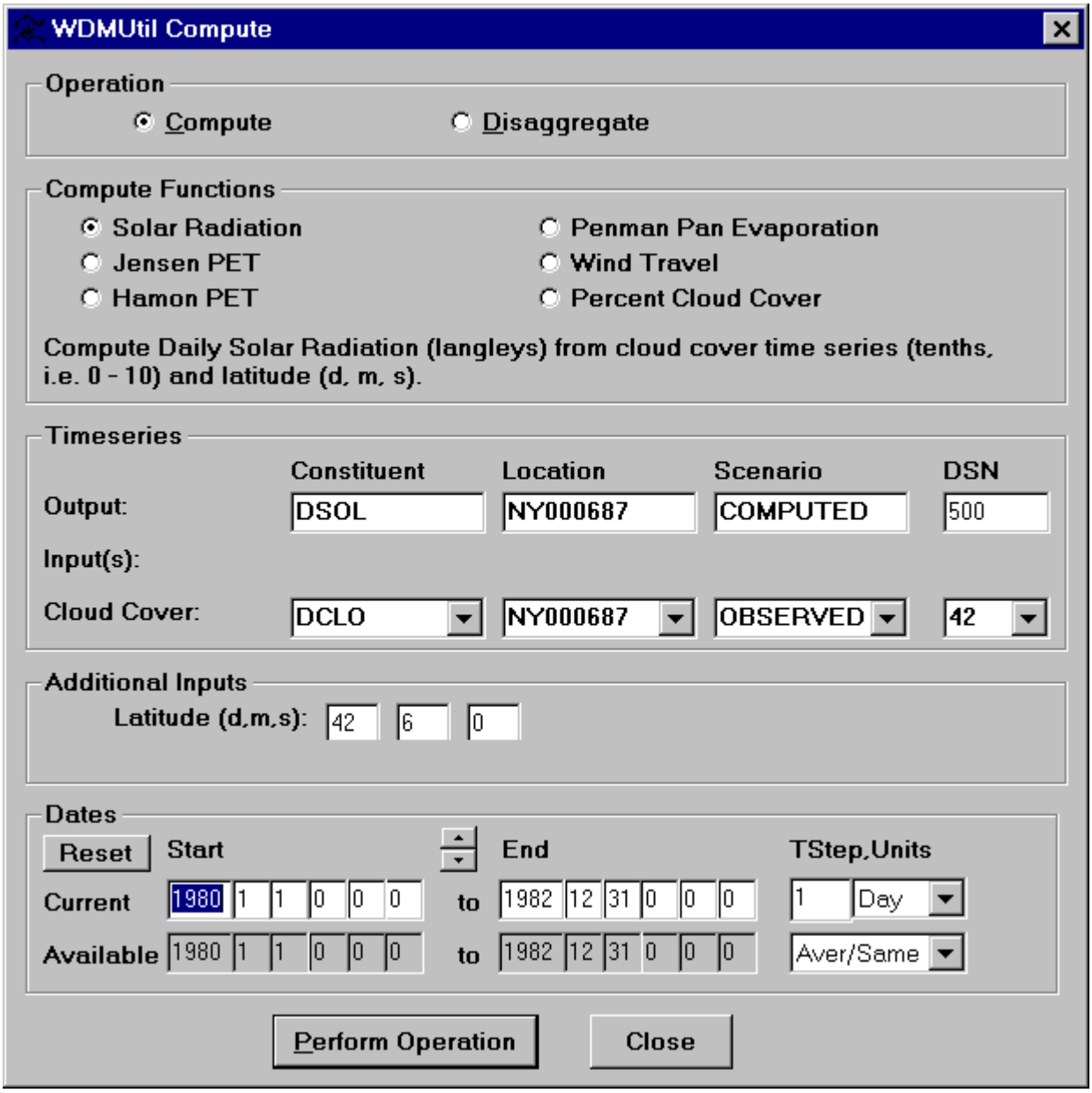
location that has daily cloud cover data. Click on the Location list and select the first item in the list after the ALL item (NY000687).



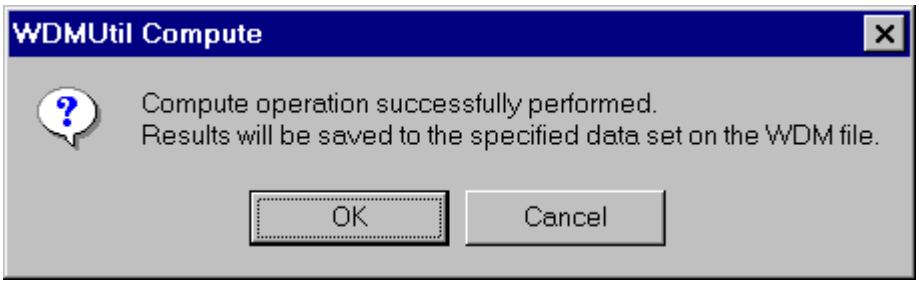
The OBSERVED displayed in the Scenario List indicates that this is the only scenario for which cloud cover data at location NY000687 exist. The 42 displayed in the DSN (data-set number) list indicates that a unique data set has been defined by the selections in the Constituent, Location, and Scenario lists. (If a user knows the number of the data set needed, they may select it from the DSN first and the Constituent, Location, and Scenario items will be filled in for that data set).

Note that default values for the output data set have been supplied as the input data set specifications were made. The only remaining item to be specified for the output data set is its number. Enter 500 in the

text field for output DSN. The only required information remaining to be specified is the longitude of the location. Enter 42, 6, and 0 in the three fields for defining the location's longitude.

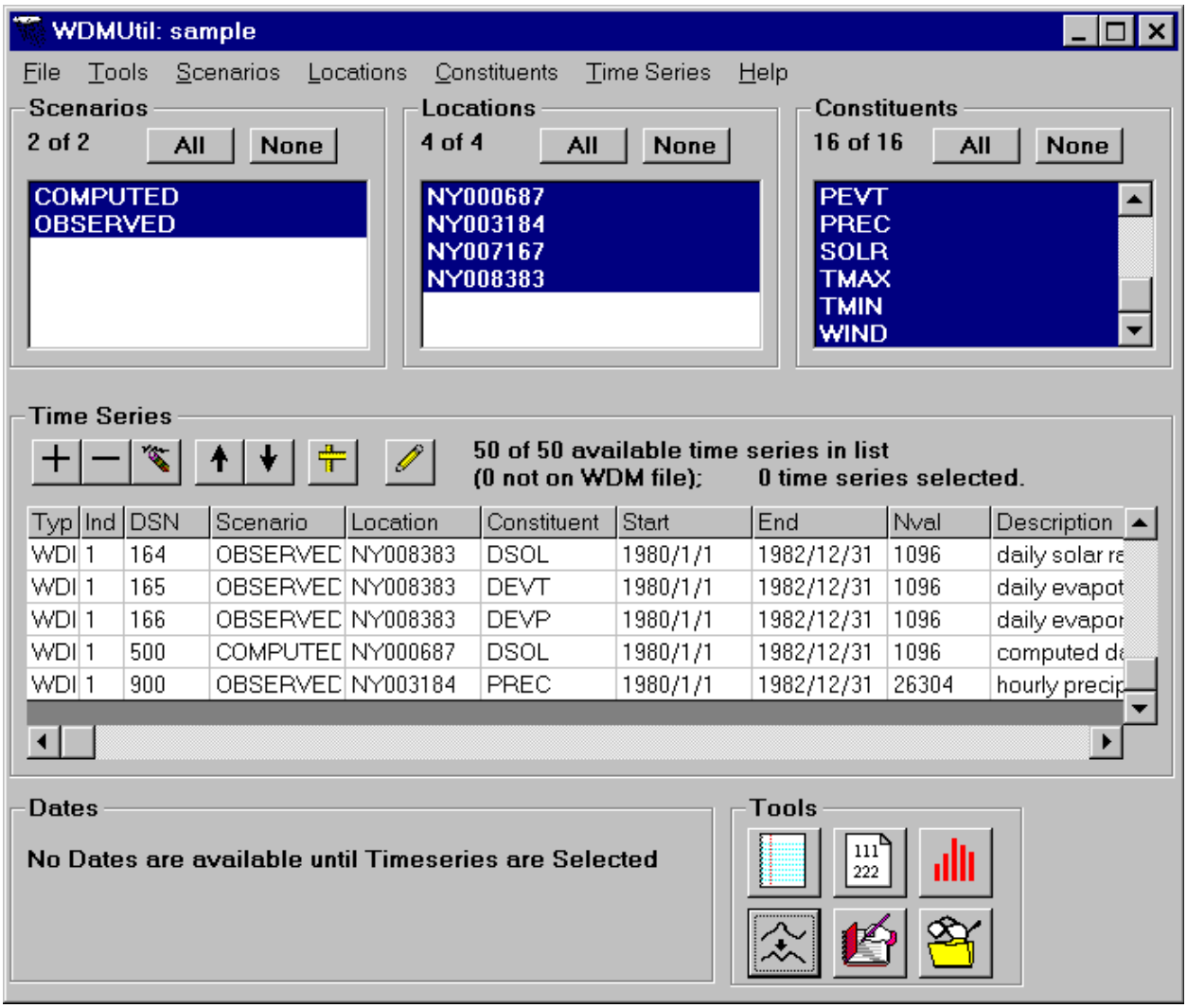


The start and end dates, displayed in the Dates frame, reflect the period of available data in the input data set. Leave the start and end dates as they are and now click the 'Perform Operation' button. A message box will be displayed indicating that the operation was successful and asking to confirm that the computed data should be stored on the designated output data set.



- Click the ‘OK’ button on this message box.
- Click the ‘OK’ button on the ensuing message box reporting that the data set was successfully stored on the WDM file.
- Click the ‘Close’ button on the Compute form.

Note that the main form has been updated to include the newly computed data set.

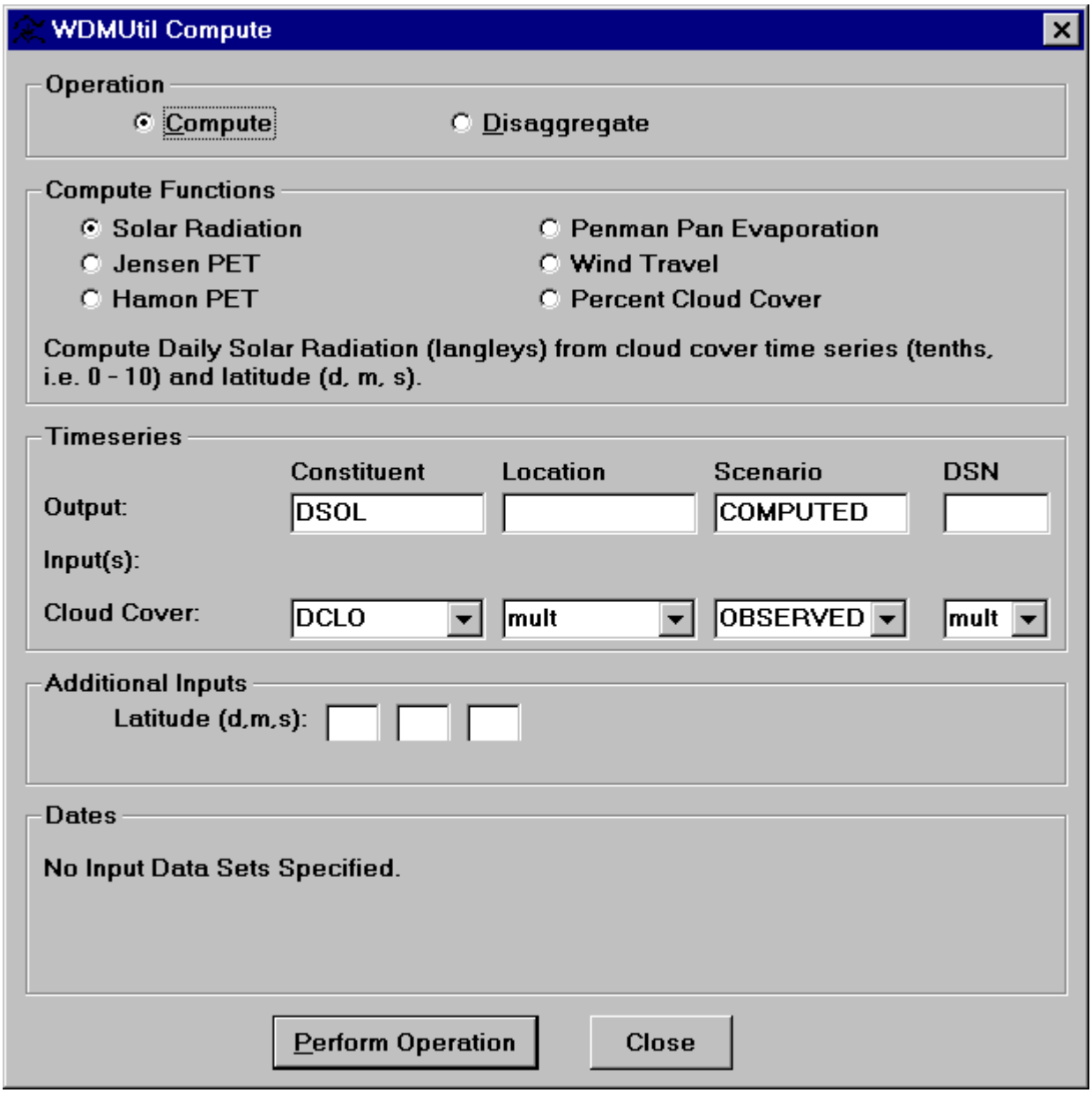


A second item (COMPUTED) has been added to the Scenario list since the newly computed data set's scenario name was COMPUTED. Scrolling to the bottom of the list in the Time Series frame will display the new data set.

2.7 Lesson 7: Disaggregating Time Series

In this lesson, the ability to disaggregate existing meteorological time-series data to a new data set will be demonstrated. When developing a BASINS study for a local area that is not near an existing BASINS WDM location, it is common to have a limited set of meteorological data available. Additionally, there is frequently even less available data at the hourly time step required by BASINS. The Disaggregate functions provide alternative methods for developing the hourly meteorological data needed for use in BASINS.

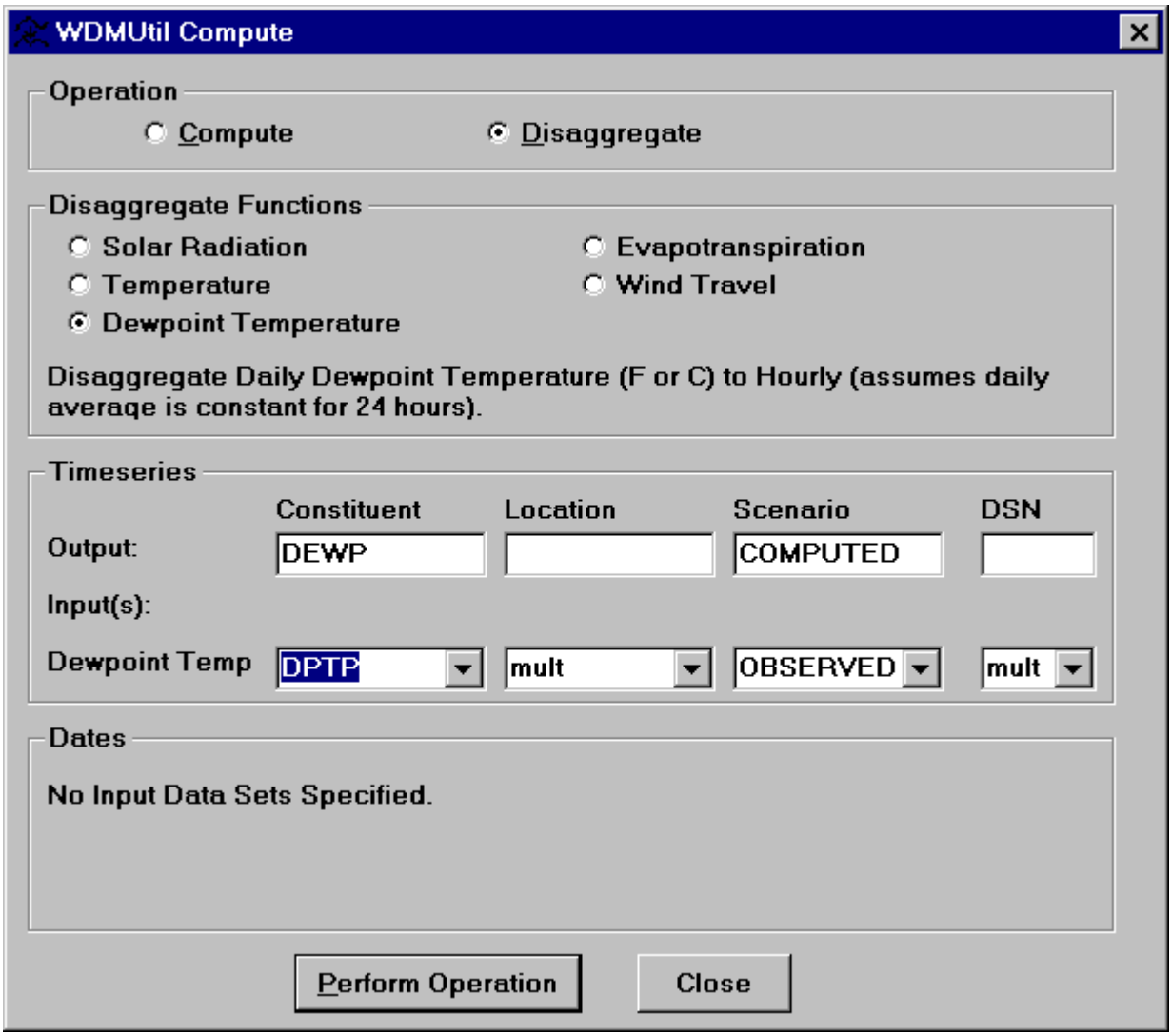
If not already running WDMUtil with the sample data, start WDMUtil and open the 'sample.wdm' file (see Lesson 1 to learn how to do this). Click on the Compute  button in the Tools frame and the Compute form will be displayed.



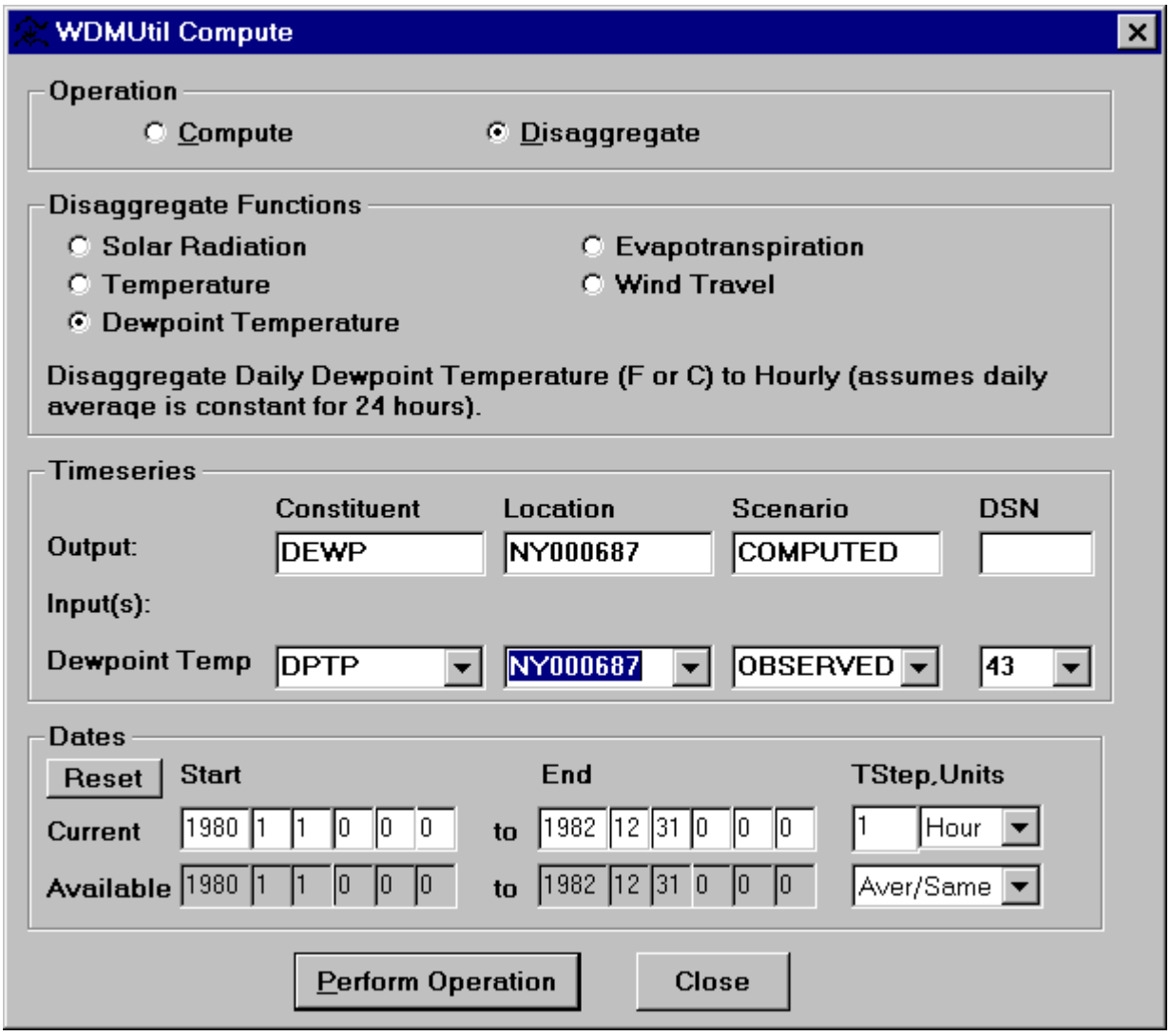
In this lesson we will demonstrate how to disaggregate daily dewpoint temperature data to hourly dewpoint temperature data.

- Select the Disaggregate option in the Operation frame.
- Select the Dewpoint Temperature option in the Disaggregate Functions frame.

The needed input and output data sets are specified in the Timeseries frame. The pull-down list next to the Dewpoint Temperature label contains all of the constituent types from the available data sets. Since WDMUtil knows that daily Dewpoint Temperature data is needed to disaggregate to hourly dewpoint, it has defaulted the list to the DPTP (daily dewpoint temperature) item.



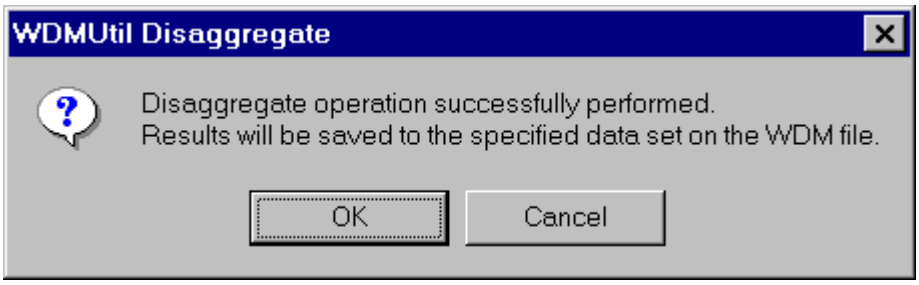
The Location and Scenario lists have now been updated to contain only items from data sets that are of daily dewpoint temperature type. The ‘mult’ displayed in the Location column indicates that there is more than one location that has daily dewpoint temperature data. Click on the Location list and select the first item in the list after the ALL item (NY000687).



The OBSERVED displayed in the Scenario List indicates that this is the only scenario for which dewpoint temperature data at location NY000687 exist. The 43 displayed in the DSN (data-set number) list indicates that a unique data set has been defined by the selections in the Constituent, Location, and Scenario lists. (If a user knows the number of the data set needed, they may select it from the DSN first and the Constituent, Location, and Scenario items will be filled in for that data set.)

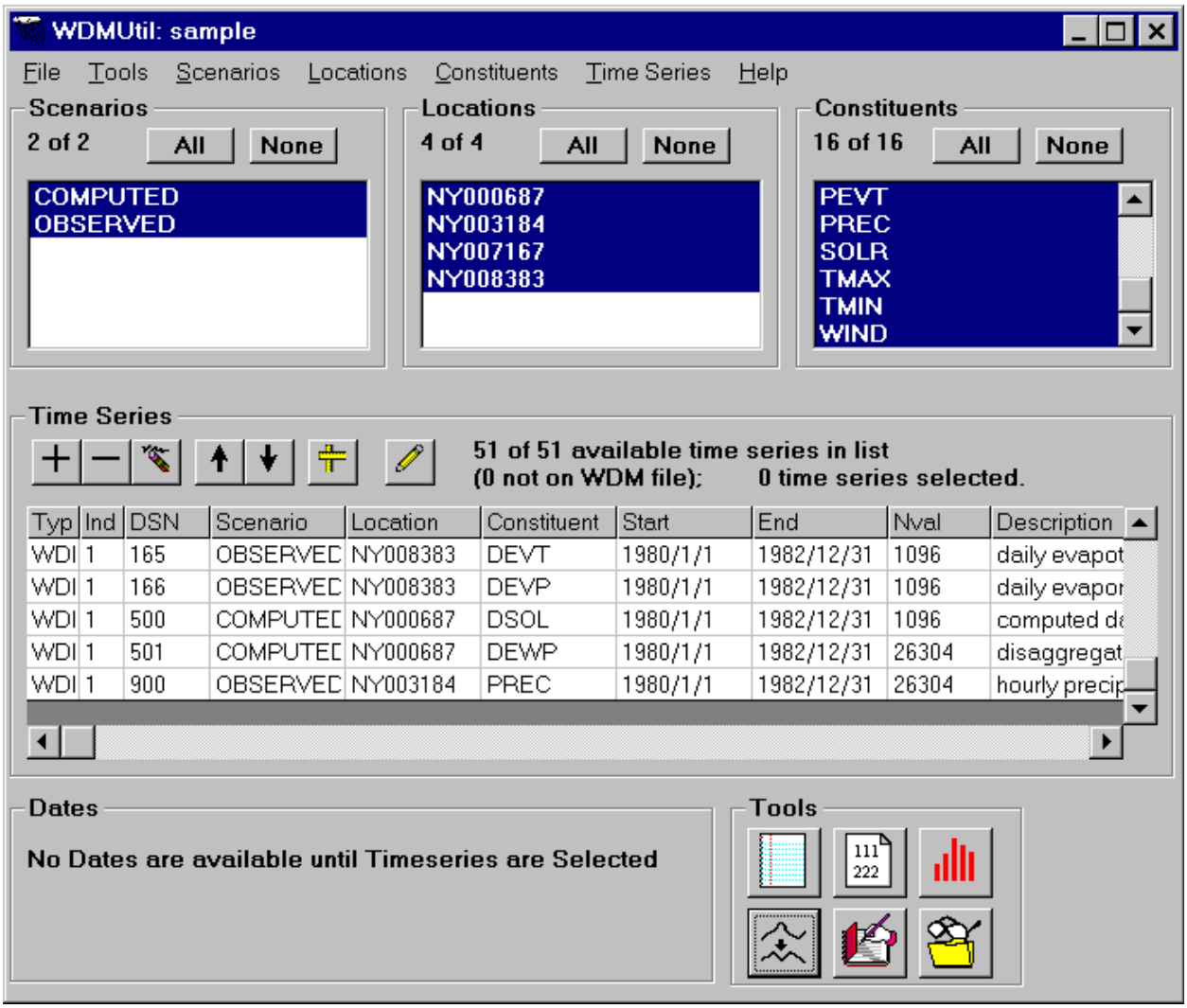
Note that default values for the output data set have been supplied as the input data set specifications were made. The only remaining item to be specified for the output data set is its number. Enter 501 in the text field for output DSN.

The start and end dates, displayed in the Dates frame, reflect the period of available data in the input data set. Leave the start and end dates as they are and now click the ‘Perform Operation’ button. A message box will be displayed indicating that the operation was successful and asking to confirm that the disaggregated data should be stored on the designated output data set.



- Click the ‘OK’ button on the message box.
- Click the ‘OK’ button on the ensuing message box reporting that the data set was successfully stored on the WDM file.
- Click the ‘Close’ button on the Compute form.

Note that the main form has been updated to include the newly disaggregated data set.



A second item (COMPUTED) item has been added to the Scenario list (if it wasn't there already) since the newly computed data set's scenario name was COMPUTED. Scrolling to the bottom of the list in the Time Series frame will display the new data set.

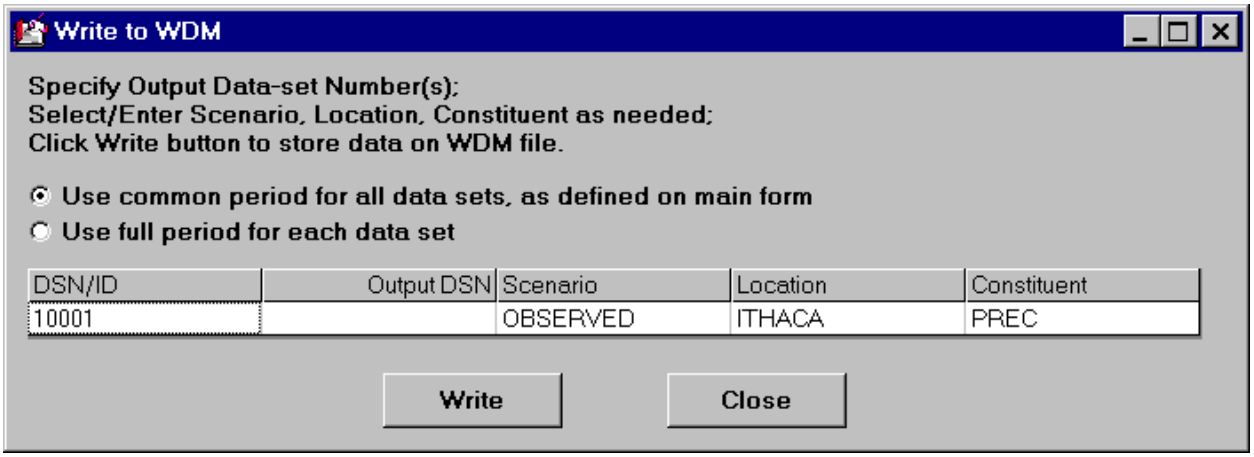
2.8 Lesson 8: Writing Time-Series Data to WDM

In this lesson, the method for writing time-series data to a WDM file will be demonstrated. It is strongly recommended that you have completed, or at least familiarized yourself with, Lesson 2. If you have just completed Lesson 2 and still have WDMUtil open, skip to the paragraph following the first figure to continue this lesson. Otherwise, perform the following steps:

- Start WDMUtil and open the 'sample.wdm' file (see Lesson 1 for details on how to do this).
- Use the File:Open menu item to open the ithaca_prec.ncd file.
- On the Data Initialization form, modify the Constituent from HPCP to PREC and the Location from 30417400 to ITHACA.
- You may also enter a description of the data (such as hourly precipitation) in the Description field.
- Change the start date to 1980, 1, 1 and the end date to 1982, 12, 31.
- Click the 'OK' button.

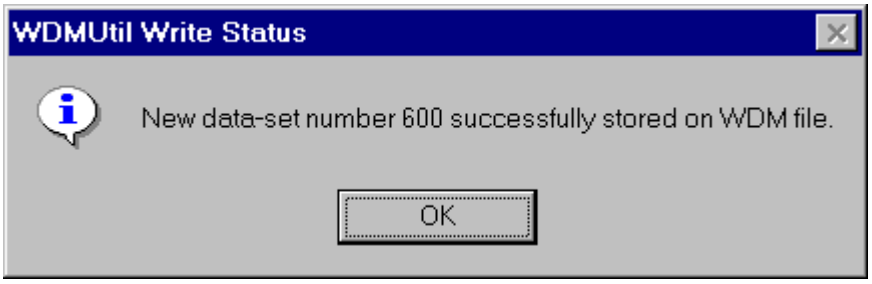
After the data has been read (and you have closed the message box indicating so), the main form should appear similar to below.

As discussed in Lesson 2, this new data has been read into the system, but has not yet been saved to the WDM file (thus its shaded background). To write this data to the WDM file, first click on it in the Time Series list. Now click the Write  button in the Tools frame and the Write to WDM form will appear.

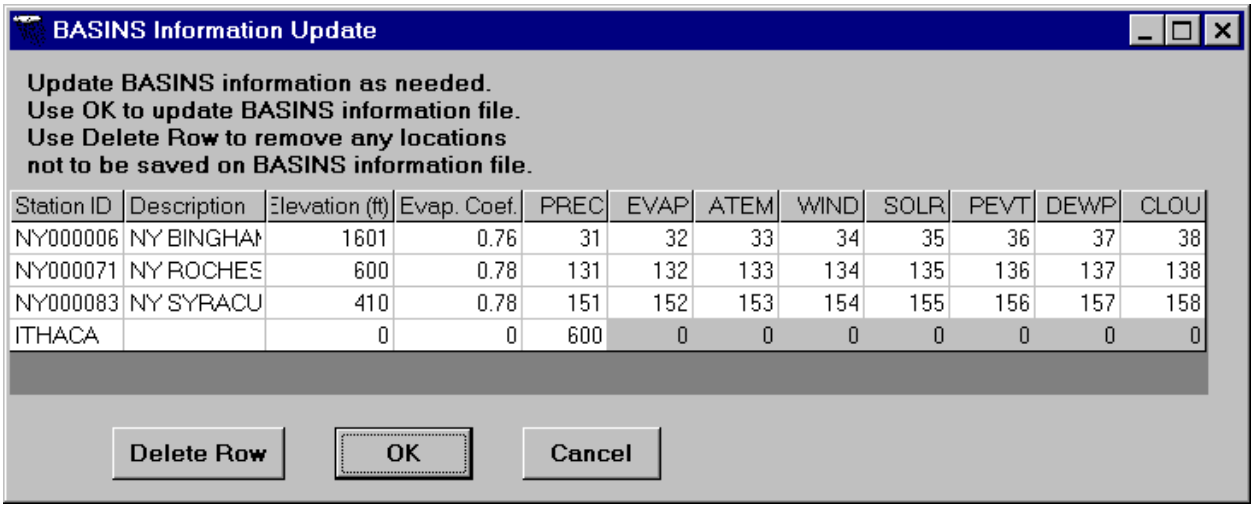


When more than one data set is being saved, an option is provided to save only the data in the time period common to all data sets or to save the full period of data for each data set. A row of descriptive

fields is displayed for each data set being saved to the WDM file. The data set's current number (or ID), Scenario, Location, and Constituent are shown along with a field for entering the data-set number on which to store the data. Valid data-set numbers (1-9999) must be entered for each data set before writing to the WDM file. The Scenario, Location, and Constituent names may also be modified before writing, if desired. For this lesson, enter 600 in the output DSN field for the one data set being saved. Now click the 'Write' button to write the data to the WDM file. A message box will be displayed indicating whether or not the write was successful.



Close the message box by clicking the 'OK' button and return to the main form. If you scroll down to the bottom of the time-series list, you will notice that the Type and DSN fields have been updated to WDM (from EXT) and 600 (from 10001), respectively, for the data set with which we were working. Now end the session by exiting WDMUtil. Since new data was saved to the WDM file, WDMUtil prompts the user to see if information for this new data should be saved on the BASINS information file.

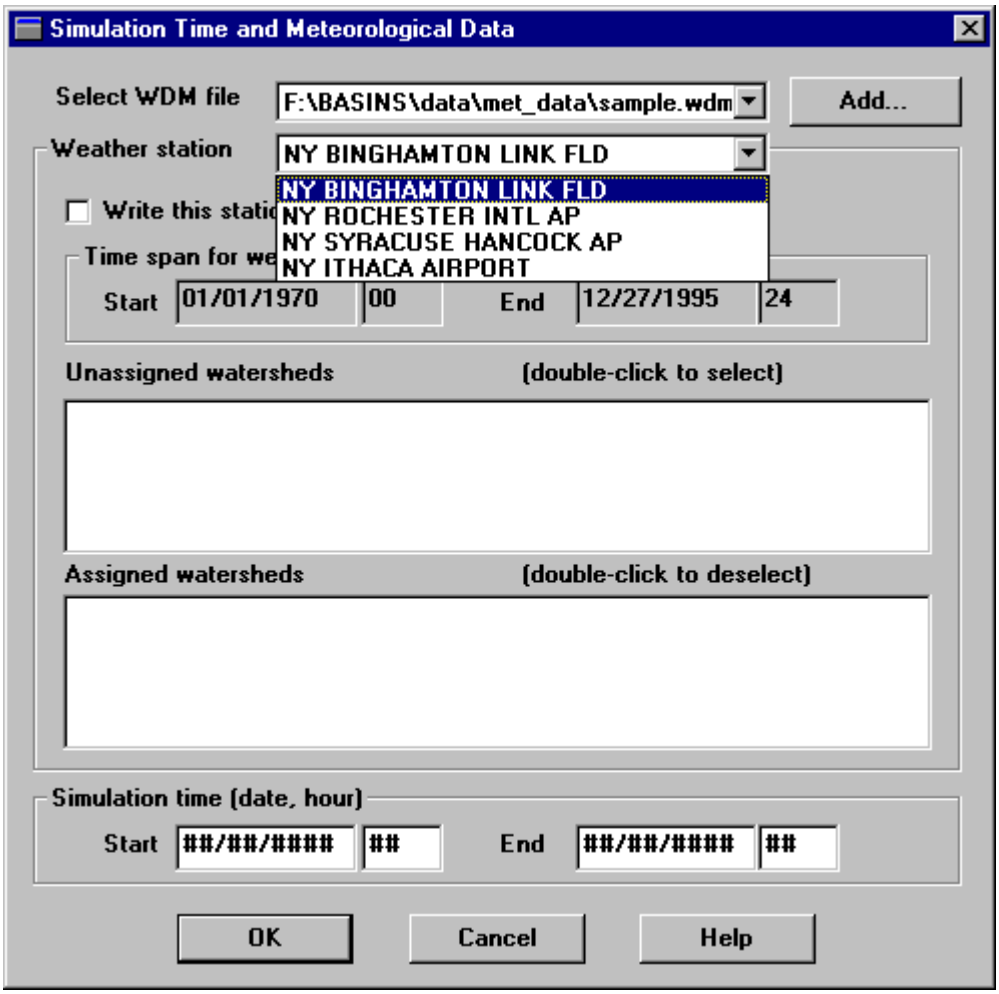


The BASINS Information Update form contains fields to provide all of the information BASINS needs about the locations on the WDM file. The rows containing a complete set of information are from previously existing locations. The final row displays the information that WDMUtil knows about the new location, ITHACA. Since we have only stored precipitation data for ITHACA, the PREC column is the only one with a valid data-set number. Other constituent's data-set numbers would become defined as further data is stored on the WDM file for ITHACA.

It is possible to use the same data set for different locations. This allows a user to import a subset of data more local to their area of interest and then use existing data from nearby locations to fill in any missing constituents.

The Description, Elevation, and Evaporation Coefficient fields must be defined by the user. Since this is only an example, it is not essential that all of the fields be defined for the Ithaca location. If you do wish to define them, you might enter Ithaca Airport for the description, 700 for the elevation, and .77 for the evaporation coefficient. If the precipitation were the only Ithaca data available, the data-set numbers for the remaining constituents would need to be defined. This would be done by copying the data-set numbers from the nearest existing location, in this case Binghampton. Clicking the 'OK' button will write the known information about ITHACA to the BASINS information file and the program will terminate. You may then view the BASINS information file (sample.inf) to confirm that the new information was added.

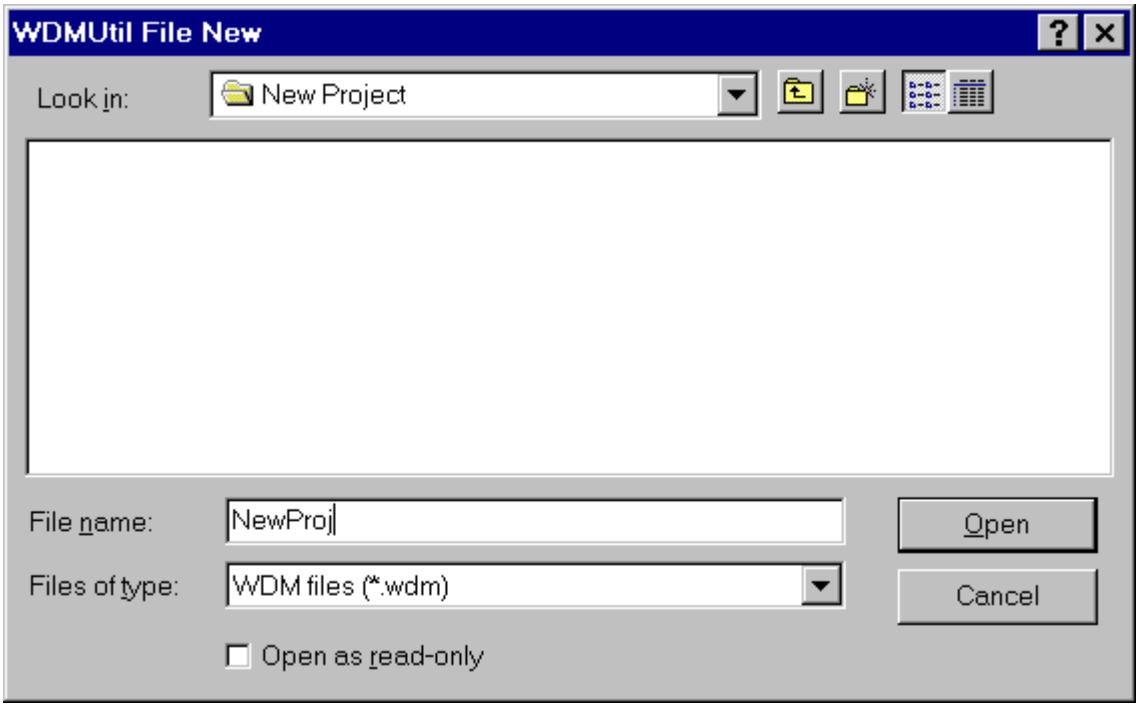
If the new Ithaca location was completely defined, the station would then be available within the BASINS system. This is shown in the following screen from BASINS NPSM.



2.9 Lesson 9: Creating a New WDM File

In this lesson, the method for creating a new WDM file will be demonstrated. Creating a new WDM file allows the user to build a WDM file that contains only the data they desire. The new WDM file is also likely to be much smaller than existing BASINS WDM files.

Begin by starting WDMUtil and then selecting the File:New menu item. A file dialogue form is displayed for specifying the name of the new WDM file.



Enter the name ‘NewProj’ in the text box for the name of the new WDM file. The file dialogue will automatically add a .wdm extension to the specified file name if the user does not provide it. Click the ‘Open’ button to create the new WDM file.

Notice that the caption on the main form displays the base portion of the new WDM file’s name. The various lists on the main form will be populated as data is read into the system and then added to the WDM file. When the new WDM file is created, a new BASINS information file (*.inf) will be created as well.

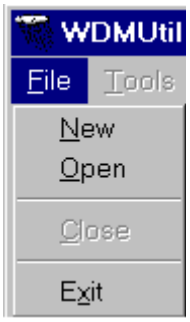
End the session by closing WDMUtil. You will notice the new WDM file residing in the directory in which it was created. You may delete this file after the session is concluded.

3 Data Access and Selection

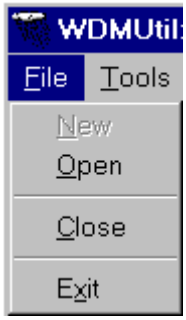
Data accessed by WDMUtil can be grouped into two general categories: WDM data and data in flat (ASCII text) files. WDMUtil requires a WDM file to be opened (or created) before any others. Once a WDM file is opened, other flat files containing data external to the WDM file may then be opened. All data access is initiated through the File menu. Both the WDM and flat files are opened using the File:Open menu item. New WDM files may be created using the File:New menu item.

3.1 File

When no WDM file is active, the available menu items under the File menu title are the New, Open, and Exit items.



After a WDM file is open, the available menu items are Open, Close, and Exit.



The File:Open option remains available to open data files containing data that is desired to be read into WDMUtil. Once a WDM file is opened, it must be closed in order to open another WDM file or create a new WDM file.

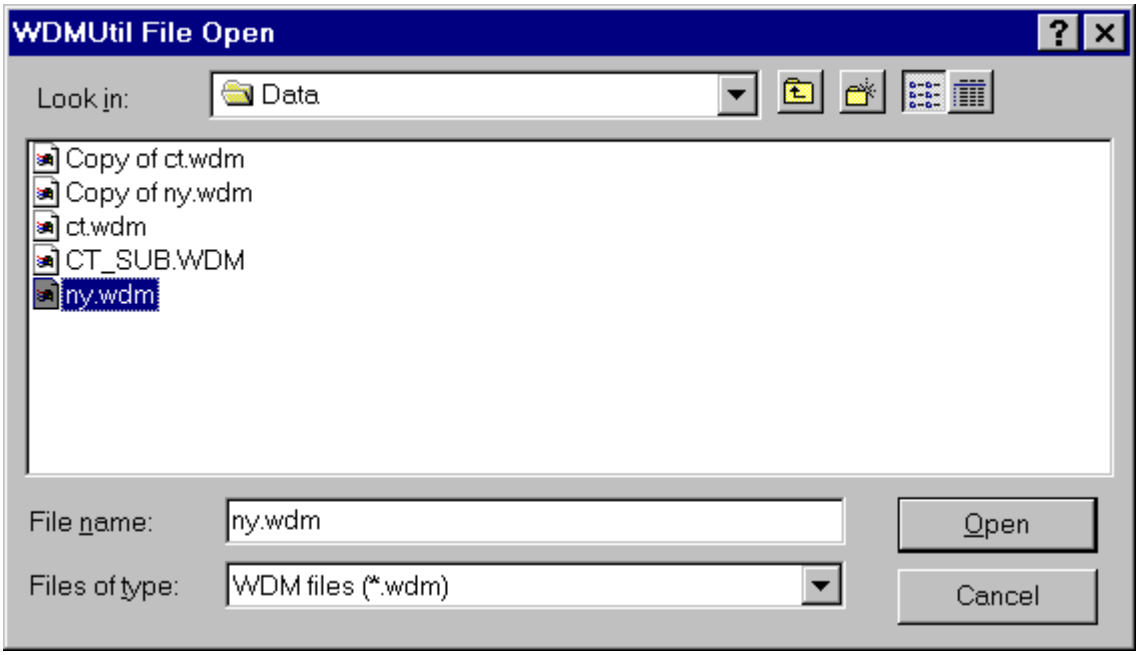
New

The File:New menu item is used to initiate the process of creating a new WDM file. Creating a new WDM file allows the user to build a WDM file that contains only the data they desire. The new WDM file is also likely to be much smaller than existing BASINS WDM files.

Selection of the File:New menu item causes a file open dialogue to appear which allows the user to enter a name for the new file. The file dialogue will automatically add a .wdm extension to the specified file name if the user does not provide it. If the file specified already exists, the user will be instructed to enter the name of a file that does not exist. After specifying the new WDM file name, the user will be asked to confirm that they want to create the file. When the new WDM file is created, the associated BASINS Information File will also be created.

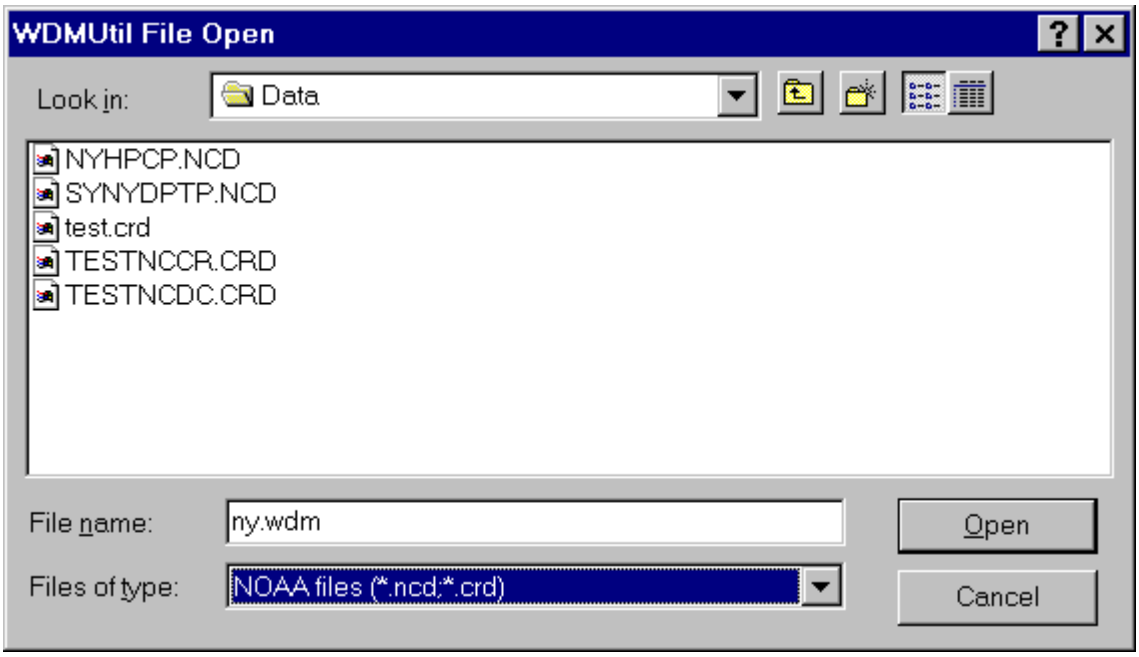
Open

Selection of the File:Open menu item causes a file open dialog box to be opened.



This dialog box is used to open the desired WDM file. Once the WDM file is opened, the WDMUtil main form will be refreshed based on the contents of the selected WDM file.

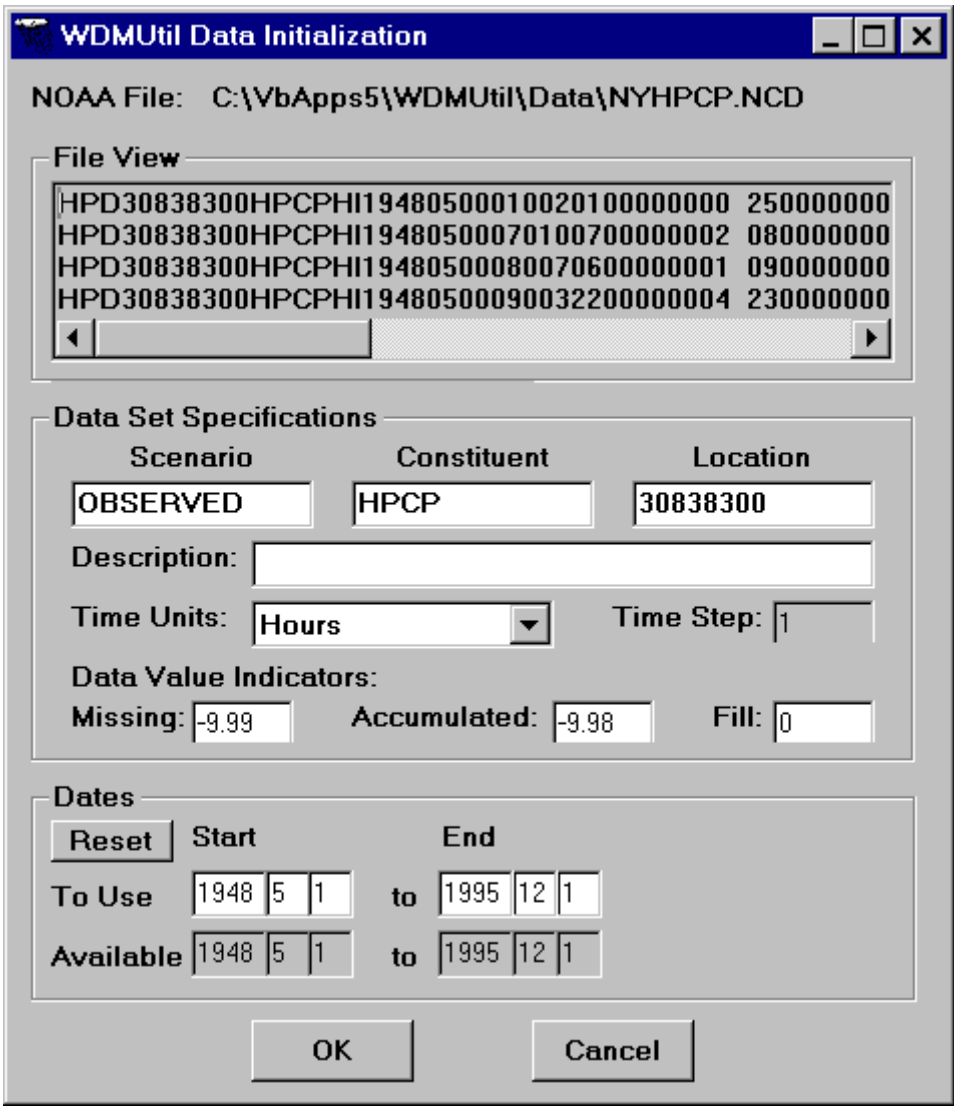
Once a WDM file has been opened, other types of files may be opened using the File:Open menu item.



These are files containing data that are not on a WDM file. These data are read into the system through the WDMUtil Data Initialization form.

Data Initialization

When a file is opened that contains data external to the WDM file, the Data Initialization form is displayed.



A label at the top of the form displays the name of the opened file that contains the data being read into the system. The File View frame displays the first few lines from the file. This allows the user to confirm that this is the expected data. When the data is not in a known format (like NOAA NCDC), additional fields are provided for the user to define the format of the data. For details on specifying the format of data, see the next section, Data Formats.

The Data Set Specifications frame contains fields for characterizing the data being read into the system. Scenario, constituent, location and description fields provide identifiers so that WDMUtil will handle the new data in the same manner as existing WDM data. Additional fields are for specifying the time units and time step and the missing, accumulated, and fill values for the data.

The missing and accumulated indicators are used when NOAA NCDC formatted data are read. WDMUtil recognizes values tagged with missing or accumulated flags and fills them with the respective value specified on this form. Missing value(s) indicate a period where no readings were made. Accumulated values (common in precipitation and other event data) indicate a reading was made, but the time at which it occurred is not known. The fill value is assigned to all values in the time series before the data are read. For event data such as precipitation, it is common to set the fill value to 0. For continuous data (temperature, evap, and so on), it is common to set the fill value to be the same as the missing value. This will initialize the time series to all missing values that will then be updated to valid values as the data are read. If a time period does not contain a valid value, it will then already be set to the missing value. This is especially useful when reading data from a format other than NOAA NCDC where WDMUtil will not be able to recognize missing value flags.

The Dates frame operates in the same manner as the Dates frame on the main form. This allows the user to read in only the time span of data desired, instead of all data in the file.

When the ‘OK’ button is clicked, the data will be read, the form will be closed, and a message will be displayed indicating whether or not the data were read successfully. If read successfully, the data are made into a time series data set that operates in the same manner as WDM data sets. It is important to note, however, that this data has only been read into the system and not saved to the WDM file. For details about saving the new data, see Section 6, Writing to WDM.

The ‘Cancel’ button will close the form and the data will not be read into the system.

Data Formats

There are two categories of data formats that WDMUtil is able to read: NCDC (National Climatic Data Center) archive and user-defined. Both of these formats are read into WDMUtil through the WDMUtil Data Initialization form. When the data are in the NCDC archive format, WDMUtil will read the data without the user defining the format. When the data are not in the NCDC format, the user will need to describe the format for WDMUtil to be able to read it. The NCDC archive format and how to specify user-defined formats are described in the following sections.

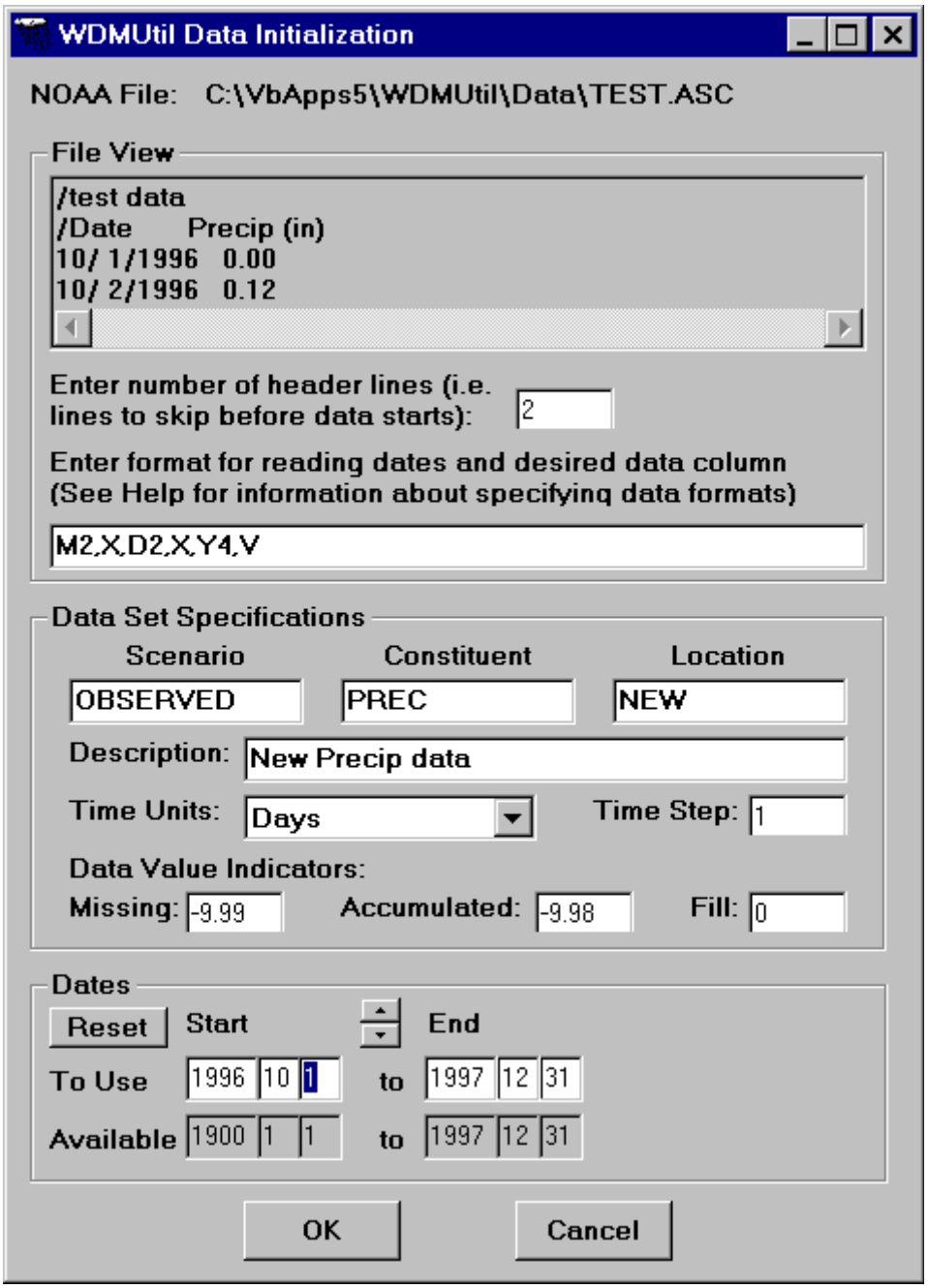
NOAA NCDC Format

WDMUtil is designed to read data that are in the NCDC archive format. These formats are published standards and are used by two of the most widely available data sources, NOAA archives and EarthInfo CDs. For documentation of these formats, see **http://www4.ncdc.noaa.gov/ol/documentlibrary/datasets.html**. The archive formats used by WDMUtil are documented in the following publications: TD-3200 Surface Land Daily Cooperative Summary of the Day, TD-3210 First Order Summary of the Day, TD-3240 Hourly Precipitation, and TD-3260 Fifteen Minute Precipitation.

For EarthInfo CDs, the Surface Airways data use the TD-3200 format, the Summary of the Day data use the TD-3210 format, and the Hourly and 15 Minute data use the TD-3240 and TD-3260 formats, respectively. EarthInfo Surface Airways data should be exported in the hourly NCDC (with CR/LF) format. EarthInfo Summary of the Day data should be exported in the daily NCDC (with CR/LF) format. EarthInfo Hourly and 15 Minute data should be exported in the event NCDC (with CR/LF) format.

Other Formats

WDMUtil has the ability to read data in user-defined formats from ASCII text files. The only restriction on user-defined formats is that the format must be consistent for all records in the file. When reading these files, the Data Initialization form displays fields for the user to specify the format.



The first field in the File View frame displays the top records in the file to assist the user in specifying the format of the data. The next field is used to specify the number of lines to skip at the start of the file for items such as comments and titles. Only records at the beginning of the file may be skipped.

The final field in the File View frame is used for specifying the format of the data to be read. The format must be consistent for all data records in the file. The Data Initialization form is designed to process only one time series at a time. Thus, if there is more than one column of data values, the format must indicate which columns to skip (if necessary) and which column to read. If additional columns are to be read, the file may be opened again and a new format entered to read the desired column.

The format of the data is specified with a series of alphanumeric characters indicating where date and data values are located. The date and time elements year through second are specified by Y, M, D, H, N, and S. Date specifiers must be followed by the field width of that element. If the data does not contain date/time information, values are assumed to start at the start date specified in the Dates frame and increment at the time interval specified by the Time Units and Time Step fields in the Data Specification frame. Data values are specified by V with an optional field width value following it. Field (or column) separators are specified by F. The field separator may be followed by the actual character separating the field or the numeric ASCII code for that character. Spaces to skip are specified by X with an optional value for number of spaces to skip following it (X by itself will skip one space). Characters used in specifying the data format may be in upper or lower case.

The following examples demonstrate how to define data formats. All data field widths are assumed to be 8 characters wide.

Data Record: 1986 10 1 45.0
Format Used: Y4,M3,D3,V8

Data Record: 10/ 1/1986 45.0
Format Used: M2,F/,D2,F/,Y4,V8

To read the second column in the next example:

Data Record: 10. 1.1986 45.0 55.0
Format Used: M2,F46,D2,F46,Y4,X8,V8

If fields are separated by tabs, to read the second column in the next example:

Data Record: 1986 10 1 45.0 55.0
Format Used: Y4,F9,M2,F9,D2,F9,F9,V

The following are the ASCII codes for some of the more common field separators.

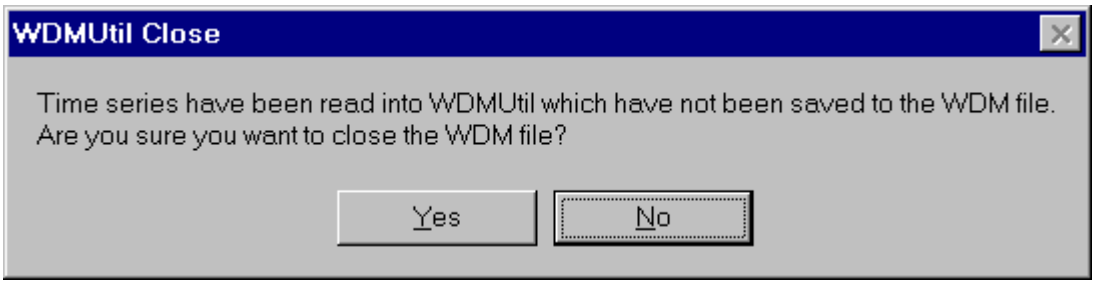
- 9 - Tab
- 46 - period (.)
- 47 - forward slash (/)
- 58 - colon (:)
- 59 - semicolon (;)

- 92 - backward slash (\)

Close/Exit

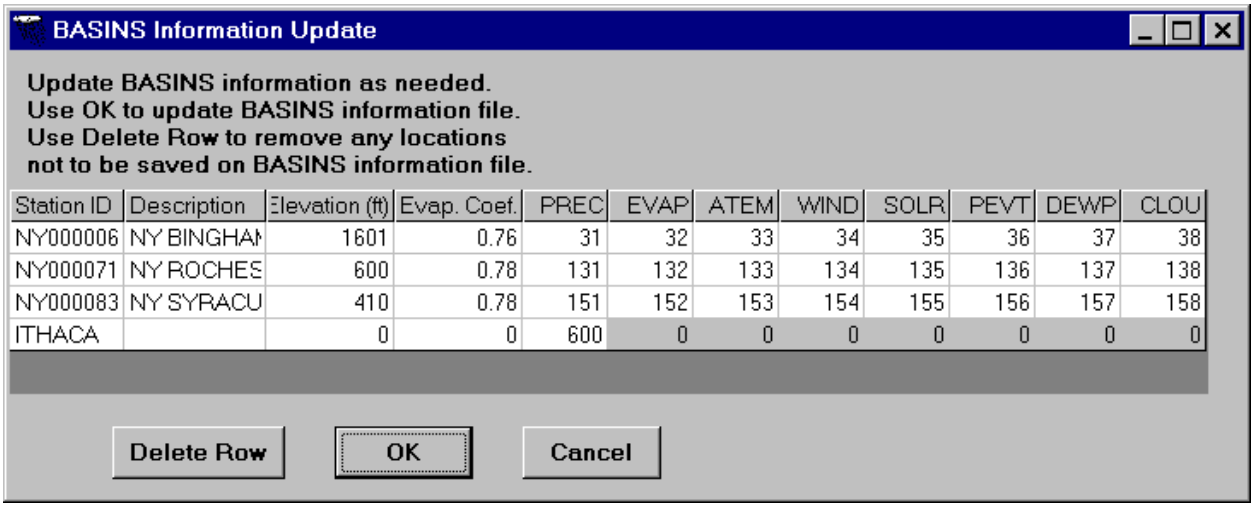
The File:Close and File:Exit menu items close the currently active WDM file. The File:Exit item additionally shuts down the WDMUtil system. During the WDM file closing, WDMUtil checks for two possibly unresolved issues.

First, it checks to see if there was data read in that has not been saved to the WDM file. If there is, the user is asked whether or not they want to close or exit without saving the data.



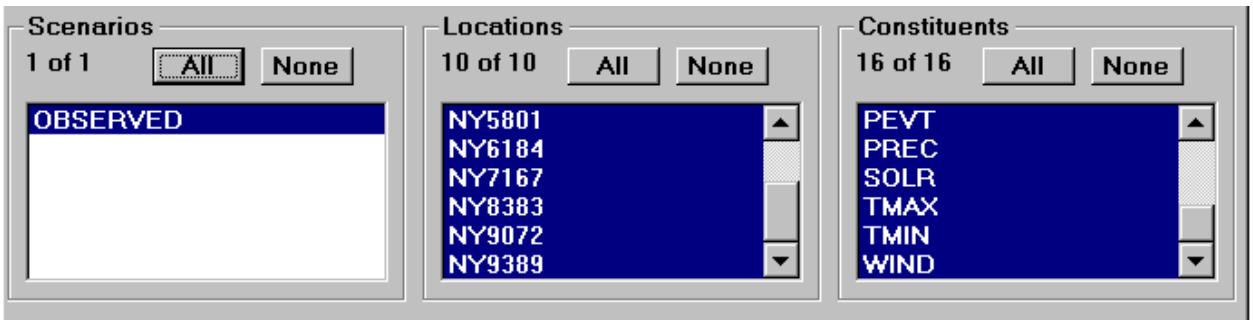
Clicking the 'No' button will return the user to the main form so that they may Write the data to the WDM file. Clicking the 'Yes' button will close the WDM file without saving the data. If the File:Exit menu item was selected, WDMUtil will be shut down.

Second, it checks to see if there were data added for any new locations that might be incorporated into the BASINS information (.inf) file. If there are new locations, the BASINS Information Update form is displayed.



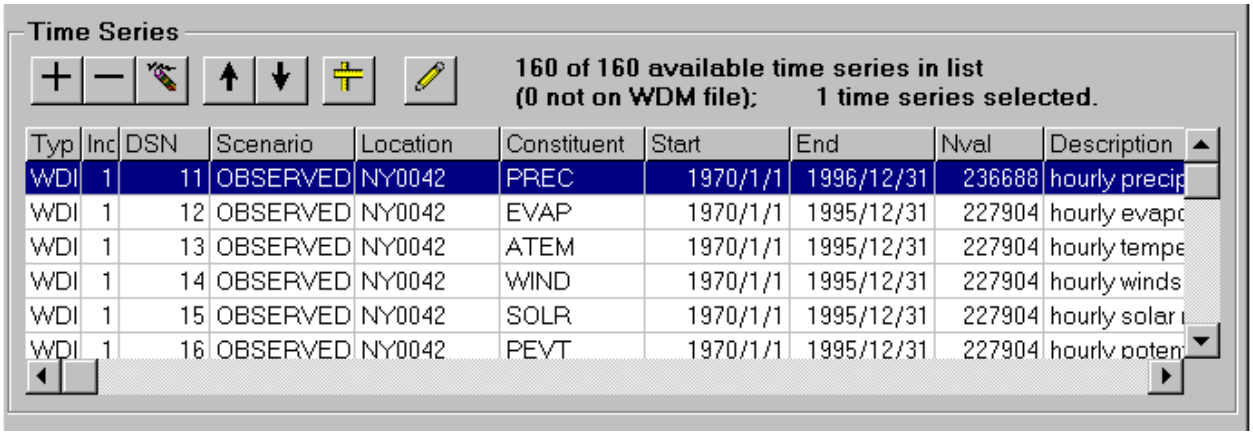
This form contains fields to provide all of the information BASINS needs about the locations on the WDM file. Clicking the 'OK' button will add the information for the locations to the BASINS information file. If the File:Exit menu item was selected, WDMUtil will be shut down. Clicking the 'Cancel' button will not add any of the location information to the BASINS information file and the user will be returned to the main WDMUtil form. For more details about this form, see Section 6, Writing to WDM, which contains information about how the BASINS Information Update form operates.

3.2 Scenario, Location, Constituent Lists



The Scenarios, Locations, and Constituents frames of the main WDMUtil form display available and selected items associated with the time series that are known to WDMUtil. The summary label in the upper left corner of the frames shows a count of the items that are selected and available. The 'All' button is used to select all available items. The 'None' button deselects all items. The list of available items is in alphabetical order with selected items highlighted.

3.3 Time Series



The Time Series frame of the WDMUtil form displays a list of the time series available for analysis. For any time series to be available to WDMUtil, three attributes must be present - constituent, location, and scenario. A toolbar and a corresponding menu title are provided to allow the user to manipulate the time-series list in a variety of ways. In the top right corner of the frame the number of available and selected time series in the list are displayed along with the number of time series which are not stored on the WDM file.

If any time series are selected in the list, the Dates frame below the Time Series frame will appear. The Dates frame includes the starting and ending dates of the period common to all selected time series in the list.

Add

The Add button in the Time Series frame is used to add time series to the time-series list. Available time series that meet the selected scenario, location, and constituent selections will be added. This allows the user to select subsets of all available time series such as all observed constituents at one location or all locations with observed dewpoint temperature. Pressing the 'ALL' button in all three lists will add all available time series to the list.

Remove, Clear

The Remove  button in the Time Series frame is used to remove time series from the time-series list. The time series must be selected in order for it to be removed from the list. Multiple time series can be removed at once by highlighting several list items and then clicking on the Remove  button. The 'Clear'  button in the Time Series frame is another way to remove time series from the time-series list. This button removes all time series from the list if none are selected. If one or more time series are selected, this button removes the selected time series plus all of the time series below it on the list.

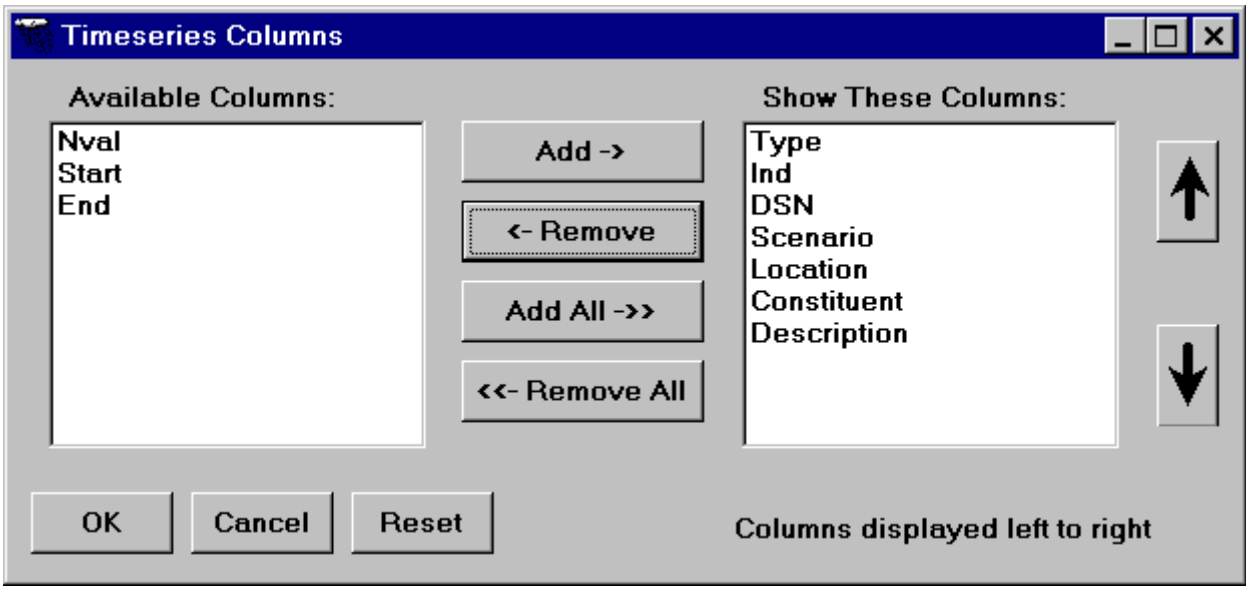
Move

The Move  buttons in the Time Series frame are used to move items in the time-series list up or down in the list. This capability may be particularly useful for those analysis options that depend upon the order of the time series in the list, such as the graphing and listing data.

These buttons require one item in the time-series list to be selected. Clicking on the arrow pointing up will move that item up one place in the list, while clicking on the arrow pointing down will move that item down one place in the list.

Columns

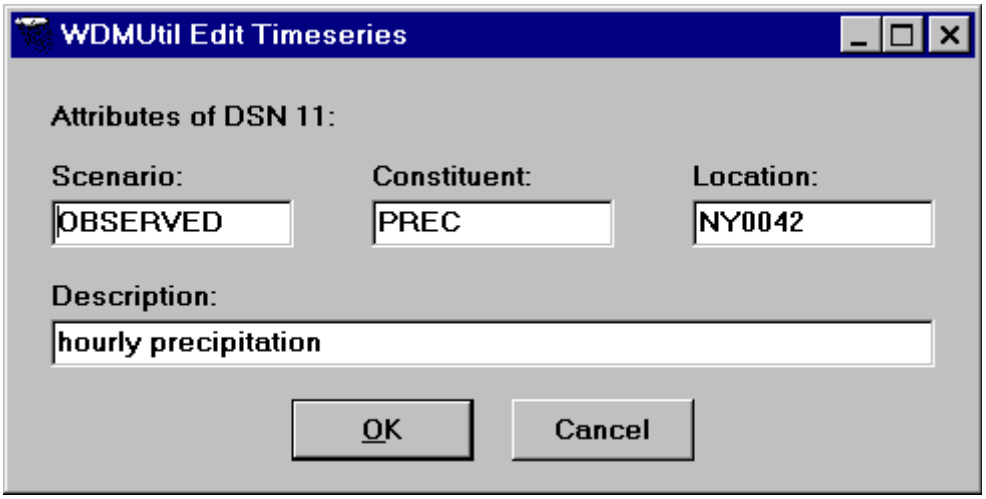
The Columns button in the Time Series frame is used to specify characteristics of the columns displayed in the time-series list. Clicking on this button produces a form that may be used to manage the columns of the list.



The Timeseries Columns form contains a list entitled 'Available Columns' and a list entitled 'Show the Following Columns.' Items are moved from one list to the other by selecting a list item and then clicking on the 'Add' button or 'Remove' button. When an item in the 'Show the Following Columns' list is selected the 'Move Up' button and 'Move Down' button can be used to move the column relative to the other columns of the time-series list. The 'Reset' button returns the columns to their default positions. The 'OK' button removes this form and applies any changes to the time-series list, while the 'Cancel' button removes this form without applying any changes to the time-series list.

Edit Time Series Identifiers

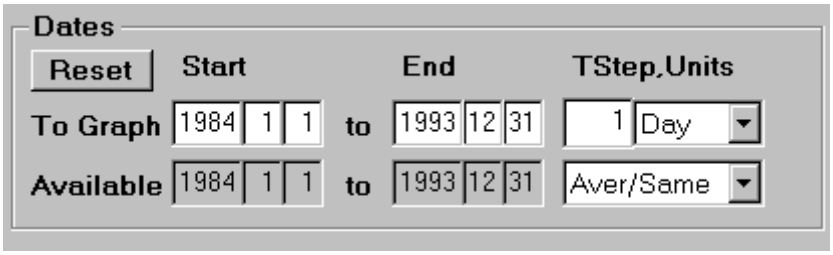
The Edit button in the Time Series frame is used to edit the attributes of items in the time-series list. This is useful for correcting typographic errors in these attributes that may have been made when the time series was read into the system. It is also useful to make time series of the same constituent type with different constituent names use a common name (e.g. DSN 1 - PREC, DSN 2 - PRCP, change DSN 2 to PREC). One or more list items must be selected before clicking on this button.



The 'Edit' form contains fields to specify the eight-character scenario, location, and constituent names as well as a description. If one list item has been selected in the time-series list, this form will appear with the attributes of that one time series. If multiple items have been selected in the time series list, this form will appear with only those attributes common to each selected time series available for editing.

The 'OK' button removes this form and applies any changes to the time series, while the 'Cancel' button removes this form without applying any changes to the time series.

3.4 Dates



The Dates frame of the WDMUtil form displays the common period of the selected time series in the Time Series frame. If no time series are selected in the list, dates will not be available.

At the bottom of the Dates frame is the available period common to each time series. Above the available period is the time span to be used in the analysis operations. The user may change the starting and ending dates for the analysis by clicking in one of these text boxes. After clicking in a text box, the user may type the number at the keyboard or use the up and down arrows that appear in the frame to move the date forward or backward. The entire date must be specified (no partial dates allowed). The 'Reset' button changes the values in the date fields back to their initial values.

The TStep and Units fields are used to set the time step and time units for the analysis operation. Below these fields is a field to set the transformation function for the analysis operation. The transformation function comes into play when the specified time interval (time step and time units) is different than that of the data set(s) being analyzed. If the specified time interval is greater than that of the data set:

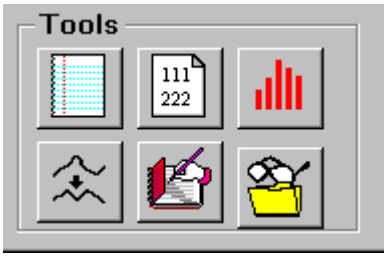
- 'Sum/Div' will sum the values over the larger interval
- 'Aver/Same' will average the values over the larger interval
- 'Max' will report the maximum value occurring during the larger interval
- 'Min' will report the minimum value occurring during the larger interval

If the specified time interval is less than that of the data set:

- 'Sum/Div' will divide the value over the smaller intervals
- 'Ave/Same', 'Max', and 'Min' will report the same value for the smaller intervals

The remaining transformation option in the list is 'Native'. Selecting the 'Native' option results in the data values being retrieved at their actual time interval, even if all of the data sets being retrieved do not have the same interval. If data sets with different time intervals are listed or graphed with the native transformation, the resulting list or graph will reflect the time interval unique to each data set.

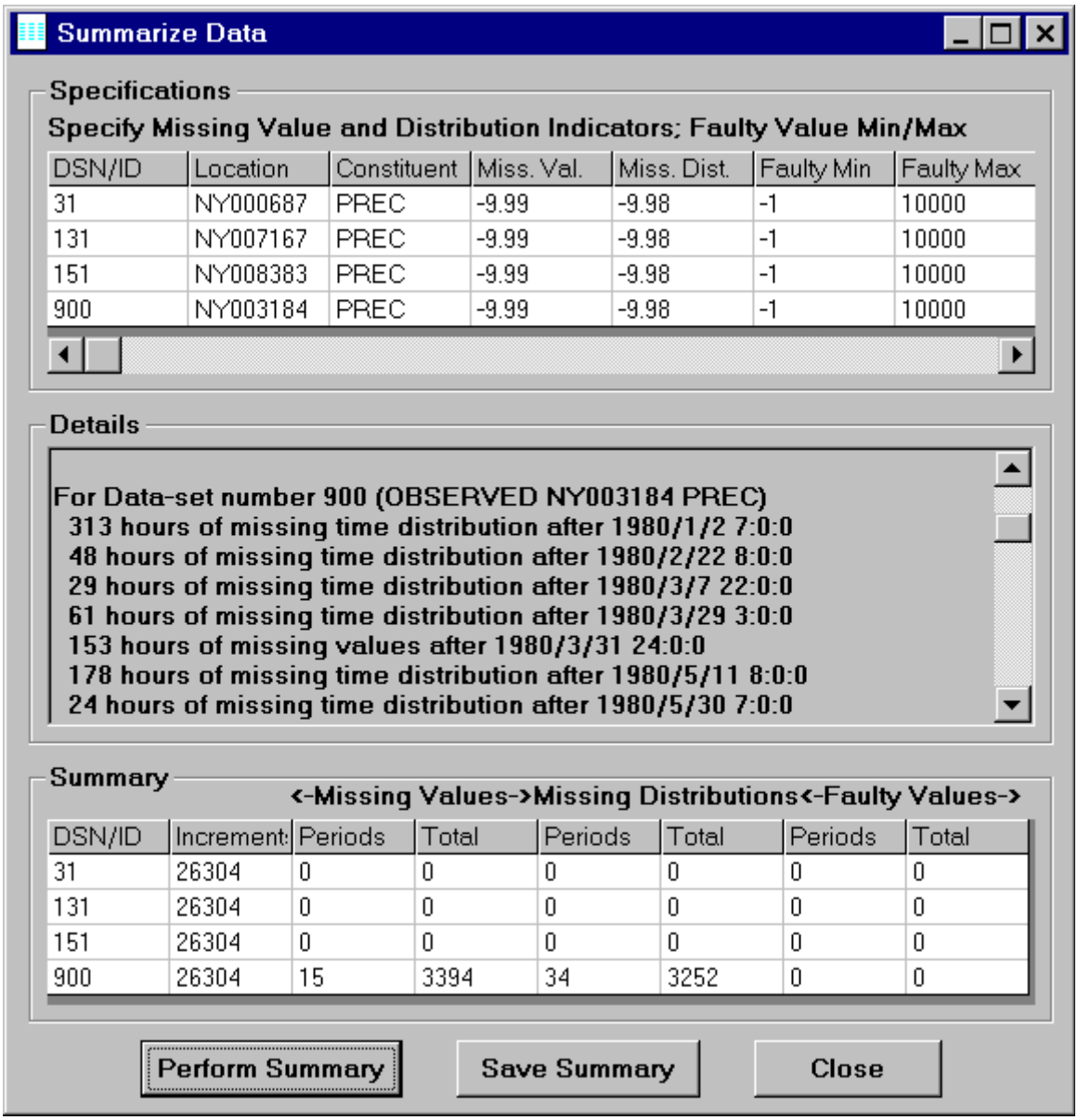
4 Analyzing Data



Analysis tools may be invoked by selecting the appropriate button from the Tools frame located in the lower right corner of the main WDMUtil form. They may also be invoked by selecting one of the menu items under the Tools menu title. The Summarize Data, Graph , List/Edit , and Write to WDM options require at least one time series to be selected in order to function. The Compute/Disaggregate option does not require any time series to be selected as time series selections are made from the Compute/Disaggregate form. The File View option also does not require any time series to be selected.

4.1 Summarize Data

The Summarize Data form is displayed by clicking on the Summarize button in the Tools frame or by selecting the Tools:Summarize menu item. The form is composed of three frames (Specifications, Details, Summary) and two buttons (Perform Summary, Close).



The Specifications frame contains a row of specifications for each data set being summarized. The first three columns are to help the user in identifying each data set and are not editable. The next two columns are used for defining missing value and missing time distribution (accumulated value) indicators. Any

data sets read in during the current session will have the values entered for missing and accumulated values on the Data Initialization form as defaults. Otherwise the missing value and missing distribution fields will be blank and need to be defined by the user. The final two fields are used for defining a minimum and maximum range outside of which values for the given constituent would not be valid.

The Details frame contains a scrollable text box that reports each instance of missing, accumulated, or faulty data. For each instance, the number of time intervals, the type of problem, and the date after which it begins are reported. If a data set has no missing data, a message indicating such is displayed.

The Summary frame contains a row of information for each data set summarized. The first two fields indicate the data-set number and the total number of time intervals that were summarized. The next two fields display the total number of periods (or instances) of missing values and the total number of time intervals in those periods. Similar totals are reported for missing time distributions and faulty values in the ensuing fields.

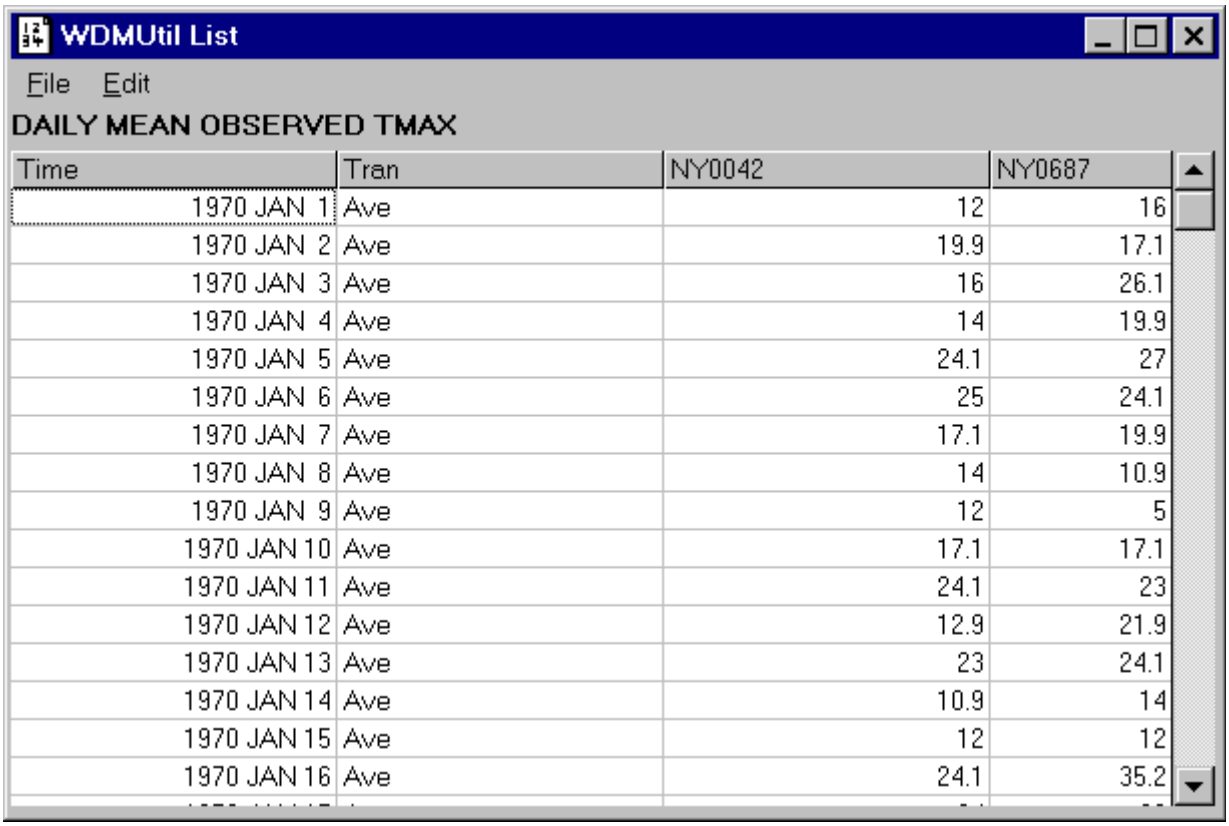
The ‘Perform Summary’ button is used to generate the missing data summary. The data sets selected from the main form will be scanned for missing, accumulated, and faulty data over the period specified in the Dates frame on the main form.

The ‘Close’ button is used to remove the form.

4.2 List/Edit

The List/Edit tool allows the user to display and edit the time-series values contained in the data sets. It allows the values to be listed at time intervals different from that of the data sets. If the values are listed at a time interval different from that of the data, the values may not be edited. Specifications about the time interval for the listing are made in the 'Tstep,Units' controls in the Dates frame. Transformations of the data from its time interval to a different one are made using the list found below the 'Tstep,Units' controls. Available transformations from one time interval to another include summing, averaging, dividing, and reporting the minimum or maximum value. For more details on how these specifications control the resulting list, see Section 3.4, Dates.

The List form is displayed by clicking on the List button in the Tools frame or by selecting the Tools:List menu item. The initial listing contains values for the selected time series displayed at the time interval and for the time period specified in the Dates frame. All lists generated by WDMUtil contain a standard set of menu items for outputting and manipulating the list. The File menu title is used to output the listed values to a file or printer and to close the list form. The Edit menu title is used to manipulate the components of the listing (title, field specifications, summary options, and date format) and to perform copy and paste functions.



Time	Tran	NY0042	NY0687
1970 JAN 1	Ave	12	16
1970 JAN 2	Ave	19.9	17.1
1970 JAN 3	Ave	16	26.1
1970 JAN 4	Ave	14	19.9
1970 JAN 5	Ave	24.1	27
1970 JAN 6	Ave	25	24.1
1970 JAN 7	Ave	17.1	19.9
1970 JAN 8	Ave	14	10.9
1970 JAN 9	Ave	12	5
1970 JAN 10	Ave	17.1	17.1
1970 JAN 11	Ave	24.1	23
1970 JAN 12	Ave	12.9	21.9
1970 JAN 13	Ave	23	24.1
1970 JAN 14	Ave	10.9	14
1970 JAN 15	Ave	12	12
1970 JAN 16	Ave	24.1	35.2

File Menu (List)

The File menu allows the user to save, print, or close the list.

Save

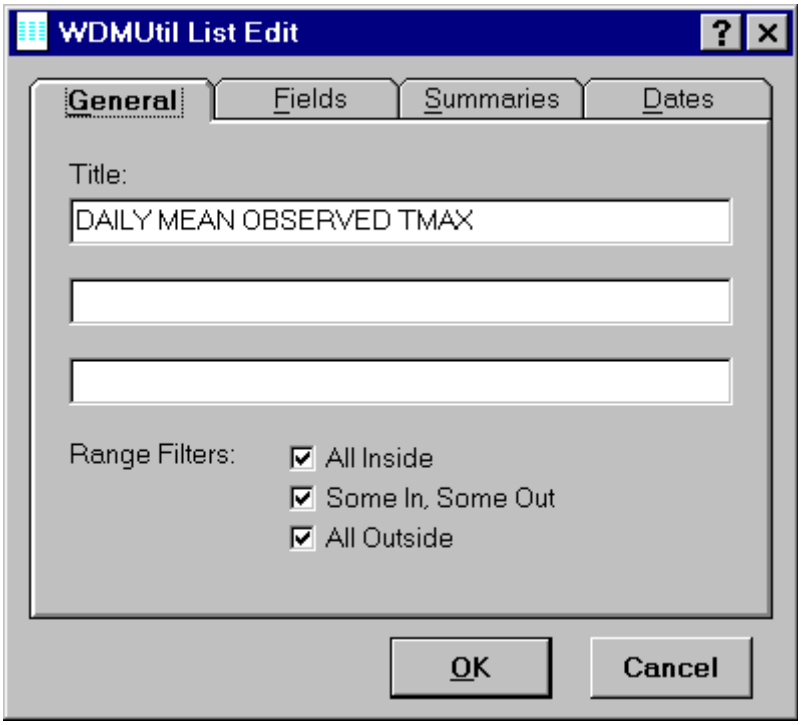
The Save menu item allows the user to output the listing to a specified file. Listings may be saved to text files in two formats: space-delimited and tab-delimited. Space-delimited files will be generated using either the *.txt or **.** file type in the file save dialogue. Tab delimited files will be generated using the *.rdb file type, where rdb stands for Relational Data Base, a common data storage system.

Edit Menu (List)

The List Edit form is displayed when any of the four menu items under the Edit menu title is selected. The form contains four tabs (General, Fields, Summaries, and Dates) with the tab corresponding to the selected menu item being in the forefront.

General (List)

The General tab contains three text fields for entering a title for the list. Below that are three check boxes for defining which records to display on the list. The “All Inside” check box indicates that only records with all data values within the range specified in the Fields tab should be displayed. The “Some In, Some Out” check box indicates that records with data values inside or outside the specified range should be displayed. The “All Outside” check box indicates that only records with all data values outside the specified range should be displayed. The performance of these buttons changes depending on whether the values are being Listed or Screened, as specified on the Fields tab.

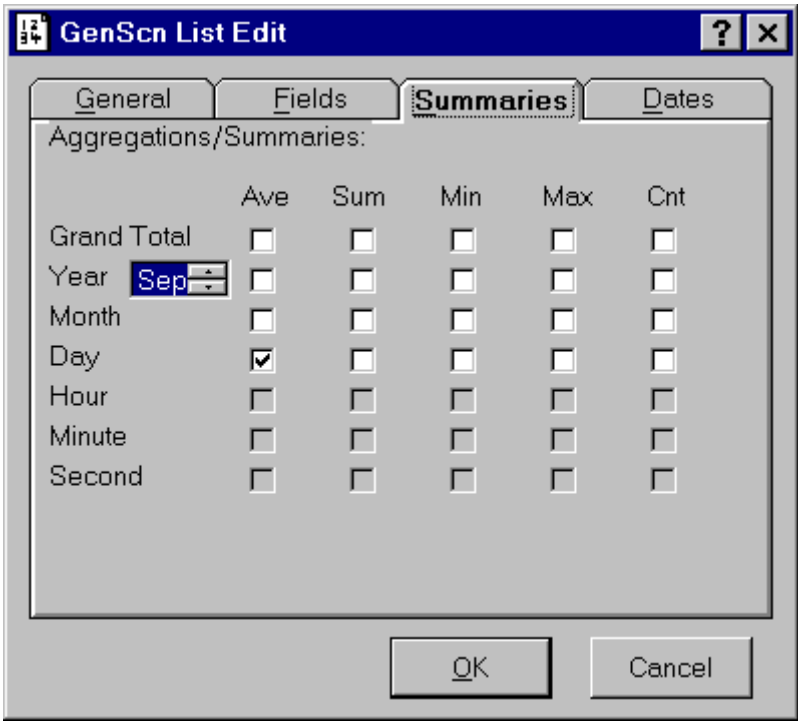


Fields

The Fields tab contains fields for specifying characteristics of each column in the list. The < and > buttons are used to select which column's parameters are being specified. The blanks in this tab are filled with values for the current field as the field is changed. The Label field is used to specify the column header. The "Width," "Significant Digits," and "Decimal Places" fields are used to specify those properties for each column. The "Min" and "Max" fields are used to specify the desired data range for each column. The "List" and "Screen" radio buttons are used to specify whether data values within the range should be listed or screened out.

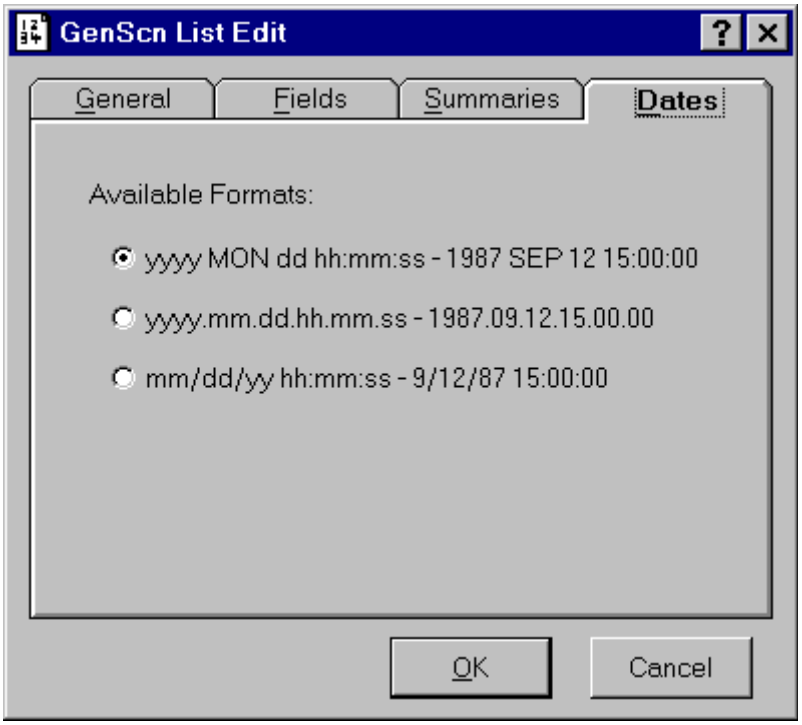
Summaries

The Summaries tab contains check boxes for indicating which time intervals and data transformations are to be listed. The transformations include average, sum, minimum, maximum, and count of values. Transformations may only be made to time intervals that are greater than or equal to the time units of the data. For example, a listing of daily data will have hour, minute, and second transformations disabled. The Summaries tab is disabled if the listing is not of time-series data. The control in the Year row allows selection of which month the year ends in. This allows use of calendar years or water years.



Date Formats

The Dates tab contains radio buttons for selecting the desired format for the date/time field. The Dates tab is disabled if the listing is not of time-series data.



Edit Values

Values in listings may be edited by clicking in the field to edit and entering the desired value. Additionally, values may be cut and pasted from one set of fields to another. First, the fields to be copied are highlighted by either clicking and dragging the mouse over them or by holding down the Shift key to define them. Second, the items are copied by selecting the Edit:Copy menu item (or typing Ctrl-C). Third, the area into which the values are to be pasted is highlighted in the same manner as the first step. Finally, the values are pasted into the defined area by selecting the Edit:Paste menu item (or typing Ctrl-V). If the defined pasting area is smaller than the copied area, only as many copied values as will fit in the pasting area will be copied. If the defined pasting area is larger than the copied area, copied values will be repeated in the pasting area as space allows.

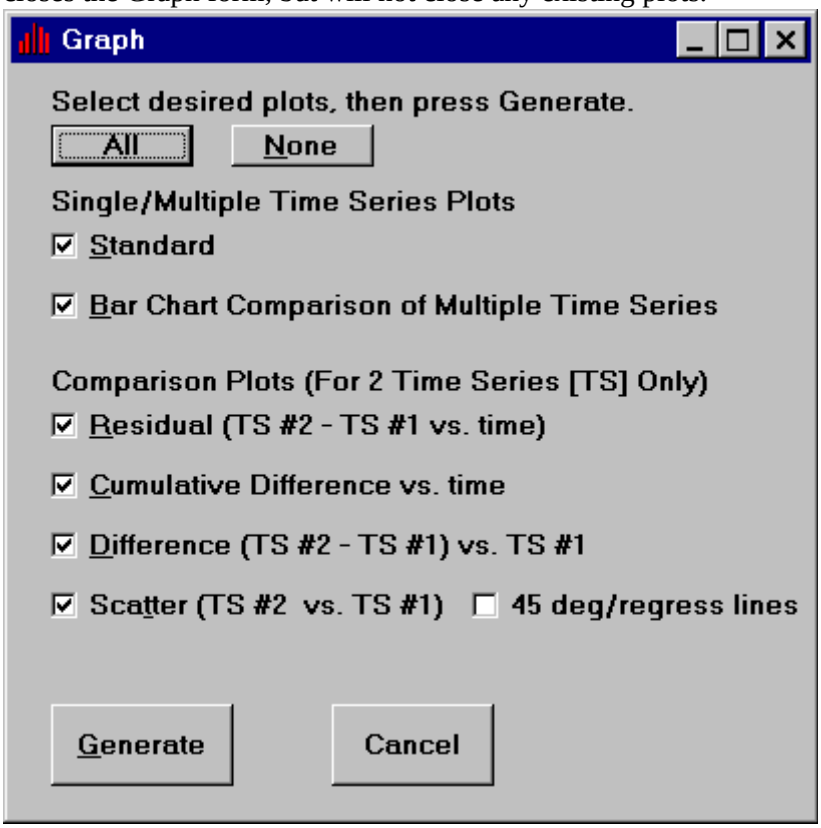
Great care should be taken when editing time-series values. Haphazard modification of values can result in misleading simulations in BASINS. Additionally, only the original time- series values should be edited. Editing of summaries added to a listing (e.g. monthly averages of listed daily values) may get incorporated back into the original data values.

4.3 Graph

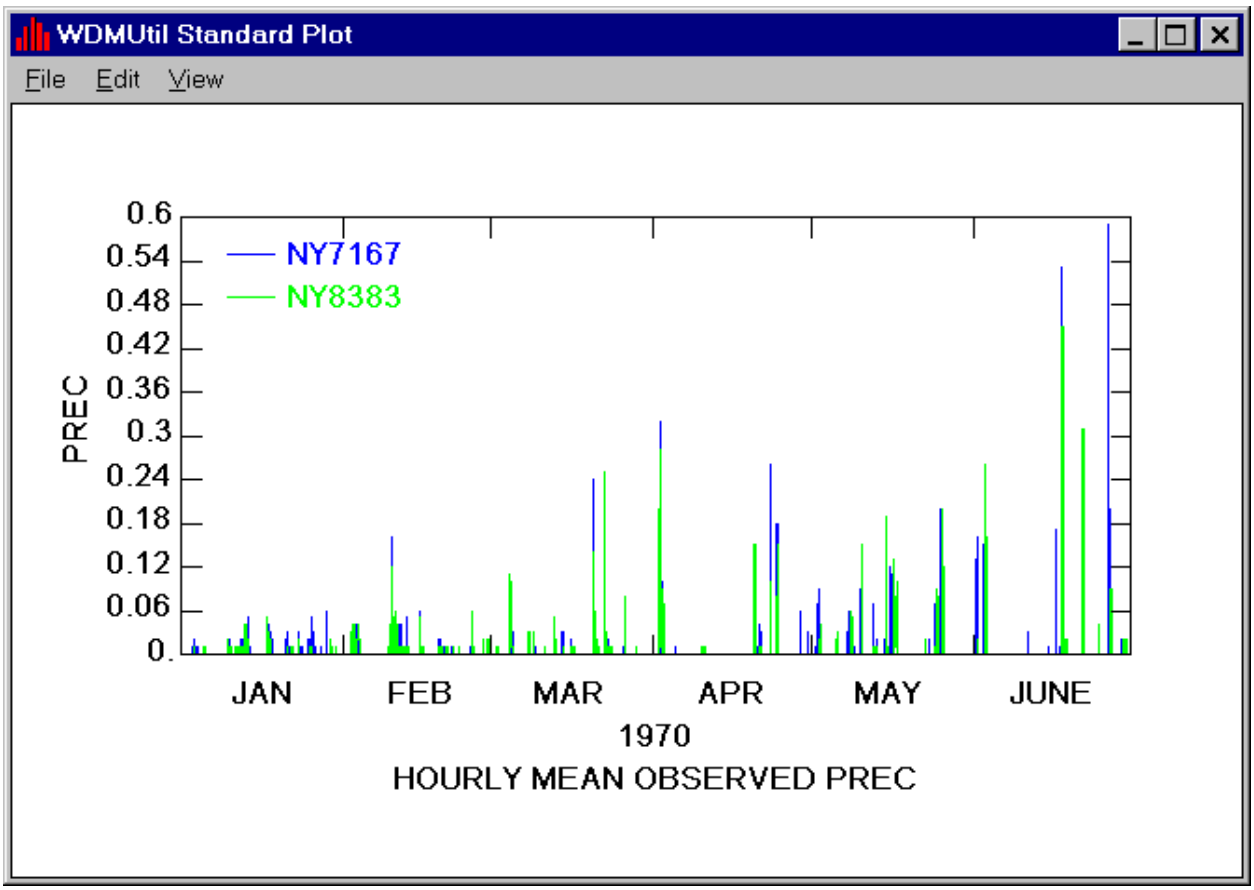
The Graph tool allows the user to generate a variety of plots for graphically viewing time-series data. All of the plots are based on time-series data, but only the Standard, Bar Chart, Residual, and Cumulative Difference, plots are time plots. The Difference and Scatter plots are x-y plots. The Standard plot is the only one that may be generated with only one selected data set. The Bar Chart plot will display two or more data-set's values side by side over time. The remaining comparison plots use only two data sets. If more than two data sets are selected for plotting, only the first two will be used when generating the comparison plots.

The time plots (standard, bar chart, residual, and cumulative difference) may be plotted at time intervals different from that of the data sets. Specifications about the time interval for the plots are made in the 'Tstep,Units' controls in the Dates frame. Transformations of the data from its time interval to a different one are made using the list found below the 'Tstep,Units' controls. Available transformations from one time interval to another include summing, averaging, dividing, and reporting the minimum or maximum value. For more details on how these specifications control the resulting plot, see Section 3.4, Dates.

The Graph form is displayed by clicking on the Graph button in the Tools frame or by selecting the Analysis:Graph menu item. The Graph form shows the suite of graphs that may be generated. If there is only one time series selected, then only the Standard plot is available as the remaining plots require multiple time series. The All button selects all of the available plots for plotting and the None button deselects them. The Generate button causes all of the selected plots to be created. The Cancel button closes the Graph form, but will not close any existing plots.



All graphs generated by WDMUtil contain a standard set of menu options for outputting and manipulating the graph. The File menu is used to output the graph to a printer or windows metafile and to close the graph form. The Edit menu is used to manipulate the components of the graph (that is, curves, axes, labels, and so forth). The View menu is used to generate a listing of the graph in a new form.



File Menu (Graph)

The File menu allows the user to print a graph, create a graphic metafile that can be imported into other applications, or close the graph.

Print (Graph)

The Print menu item allows the user to output the graph to a specified printer. The 'Properties' button on the print dialogue will allow the user to set the orientation of the graph on the printed page. It is important to remember when outputting to a black and white printer that varying the line types on the graphs (see Curves in the ensuing Edit section) will help differentiate the curves on the printed output.

Metafile

The Metafile menu item allows the user to save the graph to a file in the Windows metafile format. This is a standard graphic format that common word processors and graphics editing tools can readily import.

Close (Graph)

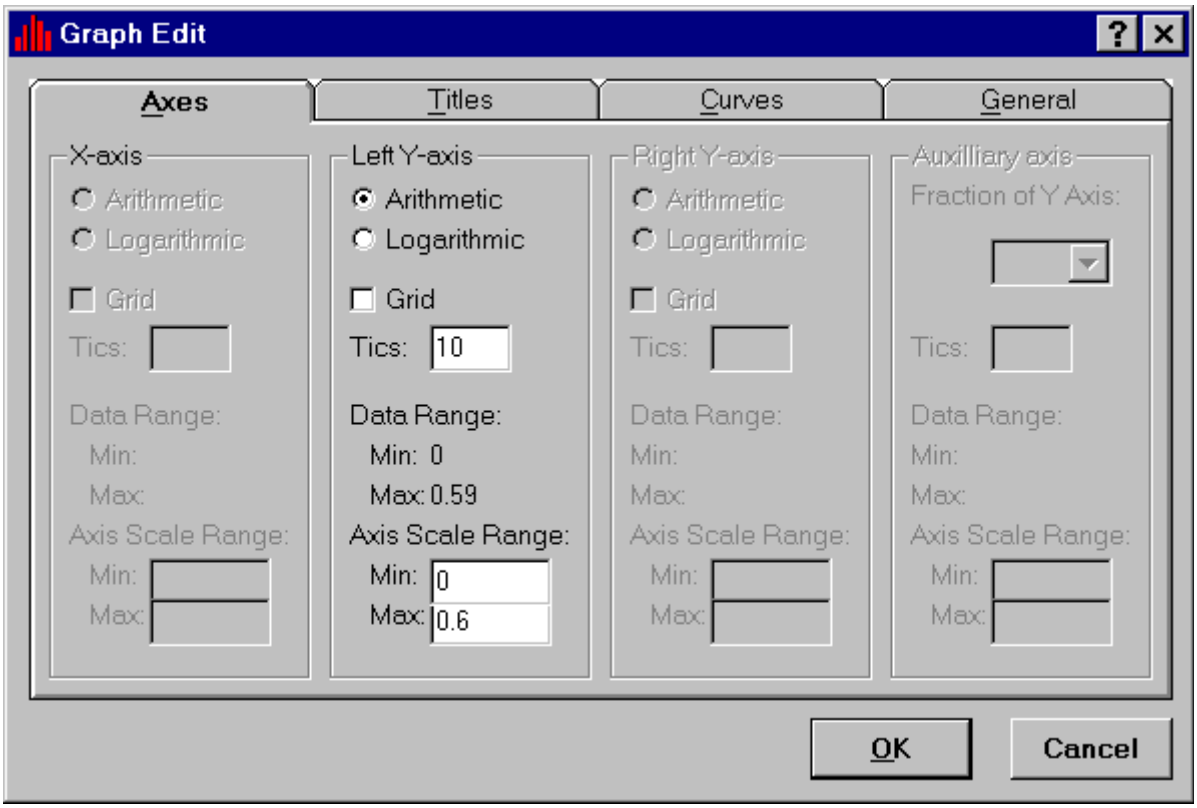
The Close menu item removes the graph form from the screen.

Edit Menu (Graph)

The Edit menu allows the user to manipulate the parameters that define how the graph appears. When a graph is first drawn it is given default values for all these parameters. The Graph Edit form is displayed when any of the four menu items under the Edit menu title is selected. The form contains four tabs (Axes, Titles, Curves, and General) with the tab corresponding to the selected menu item being in the forefront.

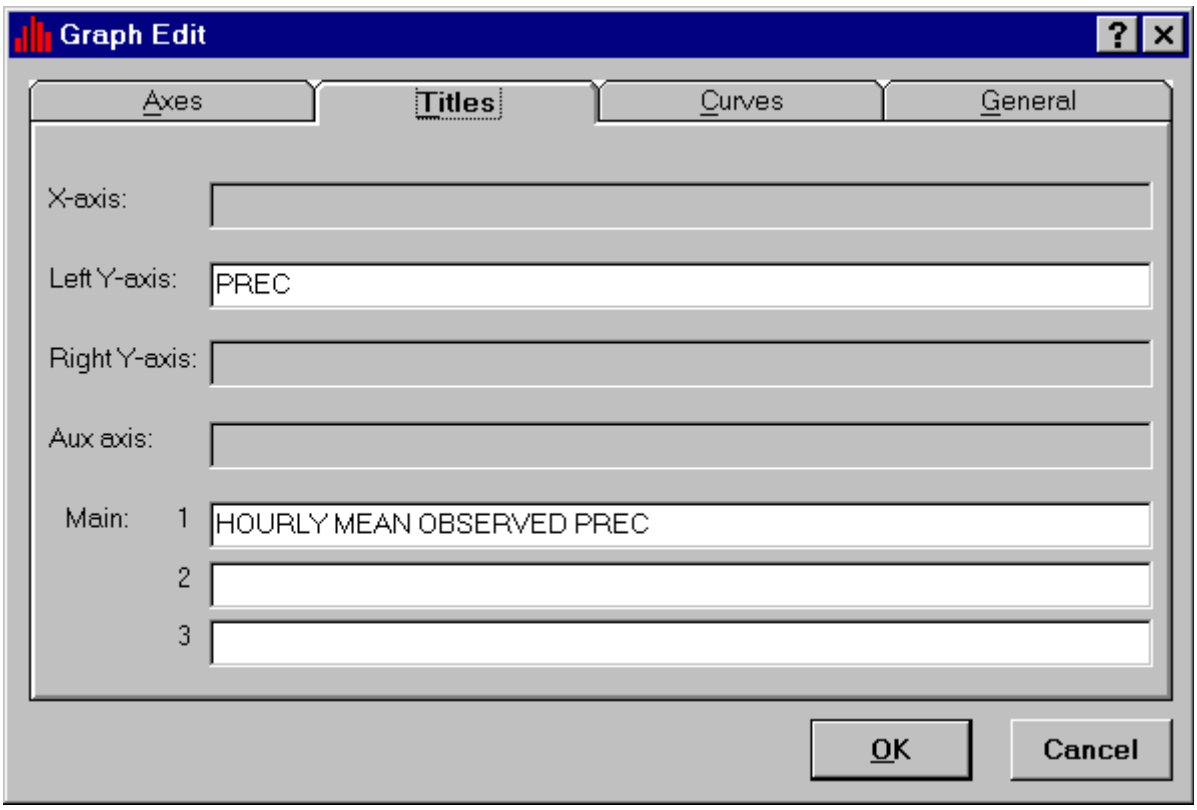
Axes

The Axes tab contains radio buttons for selecting the type of X-, Left Y-, and Right Y-axes. An auxiliary axis is a separate graph above the main graph that shares the same X-axis. A field for specifying the fraction of the available Y space to use for the auxiliary axis (if it is in use) is also provided. Each axis frame contains fields for specifying the number of tics and the minimum and maximum value for the axis. To assist in defining the axis scale, the data range for each axis is also provided. Should values exceed the axis scale range, the curve will be clipped at that point.



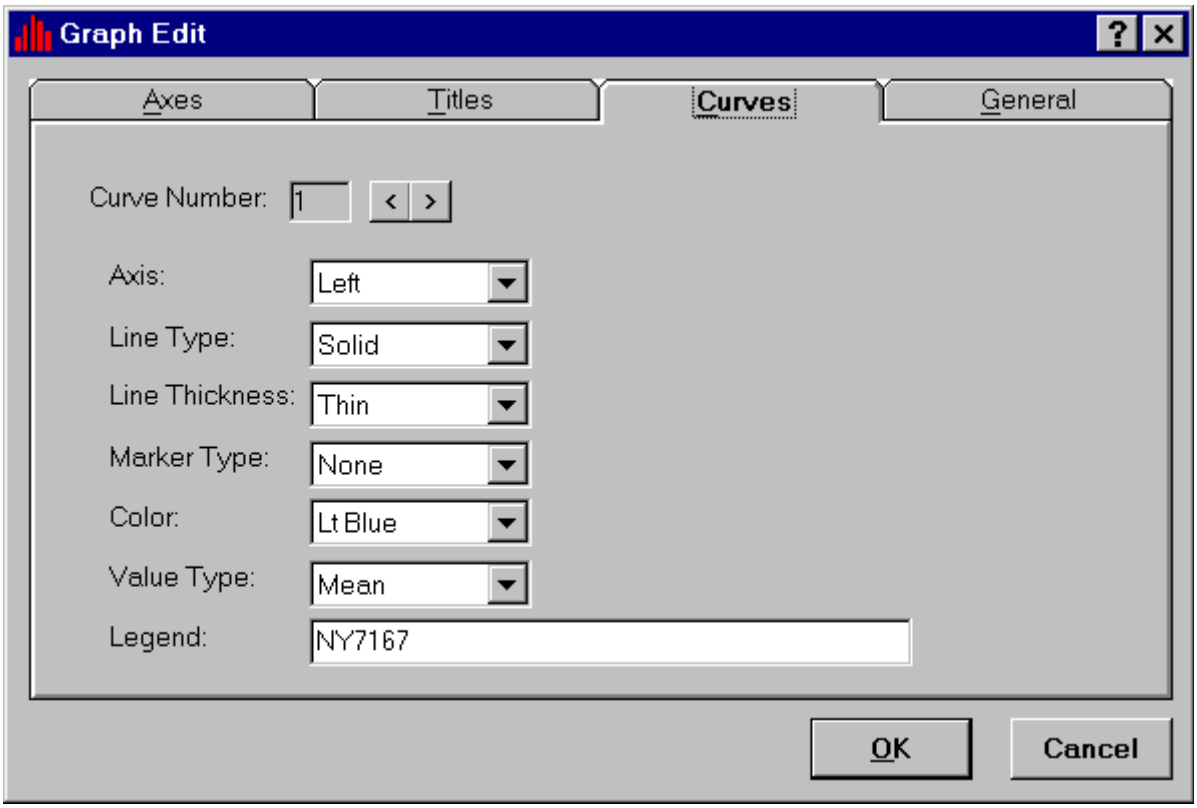
Titles

The Titles tab contains fields for specifying axes labels and the graph title. If an axis is not active, the field for its label is also not active. For a time-series plot, the X-axis label is generated automatically. Up to three lines may be entered for the main title. An additional line may be created for the left and right Y-axes labels by inserting an & symbol that indicates the start of a new line. Two additional lines may be added to the auxiliary axis label in the same manner.



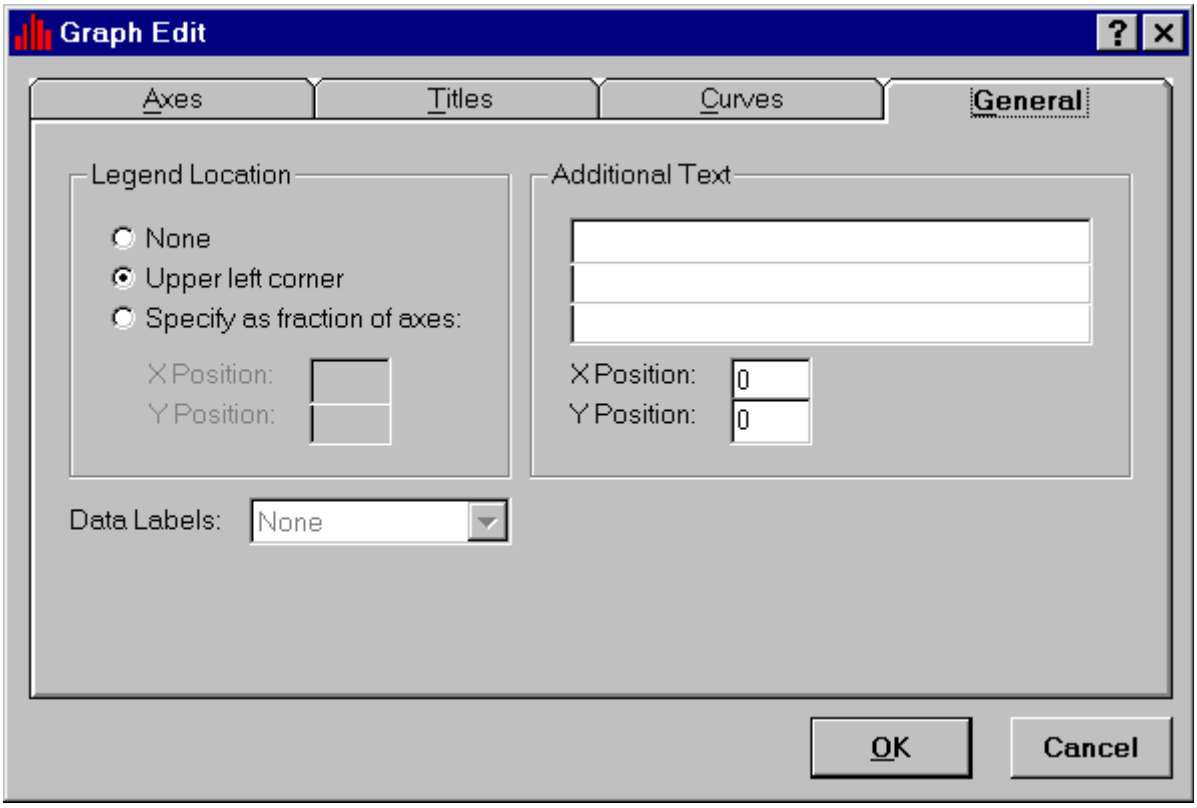
Curves

The Curves tab contains fields for specifying characteristics of each curve on the plot. The < and > buttons are used to select the curve to specify parameters for. Properties that appear in this tab reflect the current values for the selected curve. The Axis field specifies on which axis the curve is to be plotted (Left Y, Right Y, Auxiliary). Specifications for line type and thickness, marker type, color, value type (mean over a time span or point at an instant of time), and legend label may also be made. All specifications except legend label are selected from drop-down lists.



General (Graph)

The General tab contains radio buttons and fields for specifying the location of the legend. Location options include no legend, the upper left corner (default), and a user-specified location. Three additional text fields are provided to add any additional text to the plot. Location specifications for both the legend and the additional text are made by entering the fraction of the X- or Y-axis (for example, X Position=0.5, Y Position=1.0 means half way across the X-axis and at the top of the Y-axis).



View Menu

The Graph View menu title contains two items: Listing and Copy.

Listing

The Listing menu item creates a text listing of the data that are plotted on the graph. For a time-series plot, the first column of the listing displays the date and time and the remaining columns display the values for each curve. For x-y plots, first the y and then the x data for each curve are displayed.

Copy

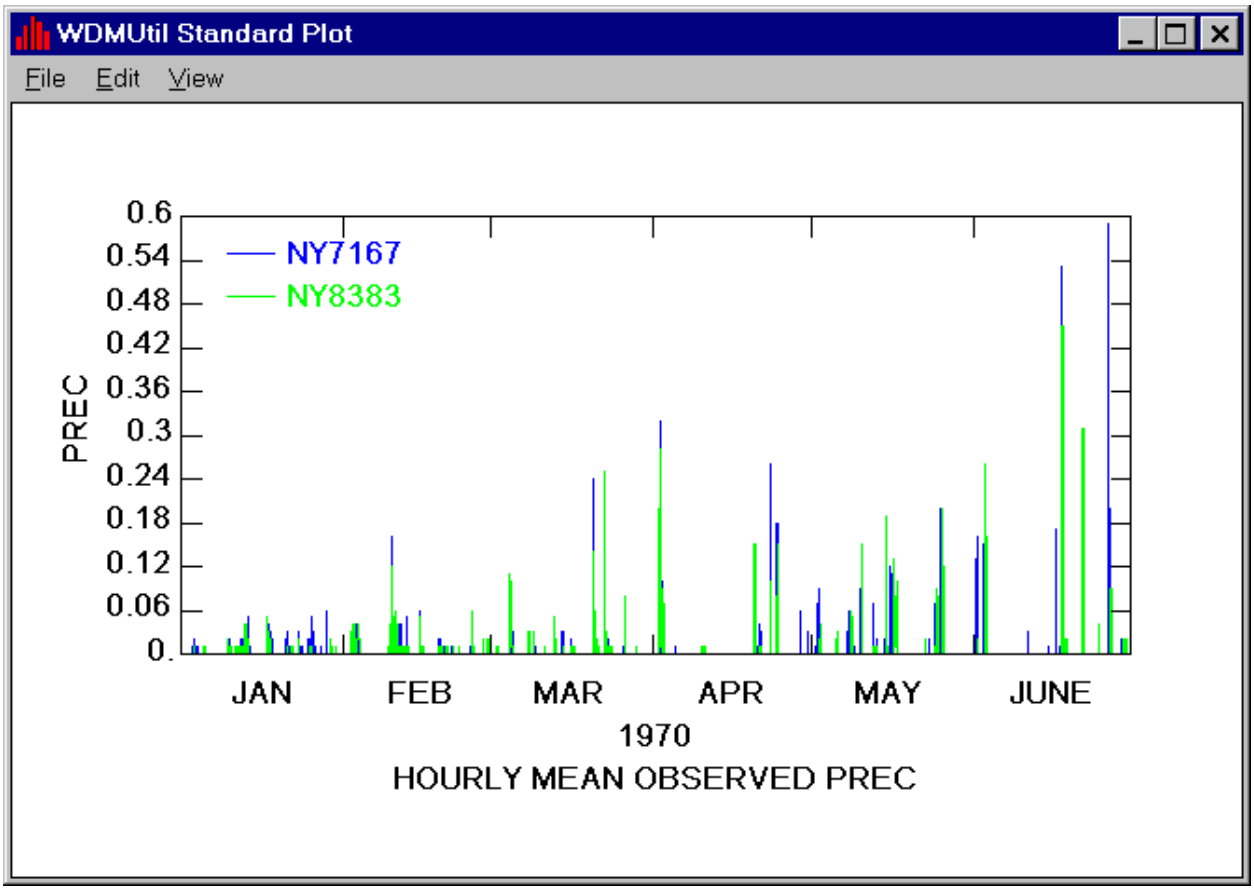
The Copy menu item is intended to create a copy of the current graph for further manipulation. This option is not currently implemented.

Graph Types

Several types of plots can be generated: standard, bar chart, residual, cumulative difference, difference, and scatter.

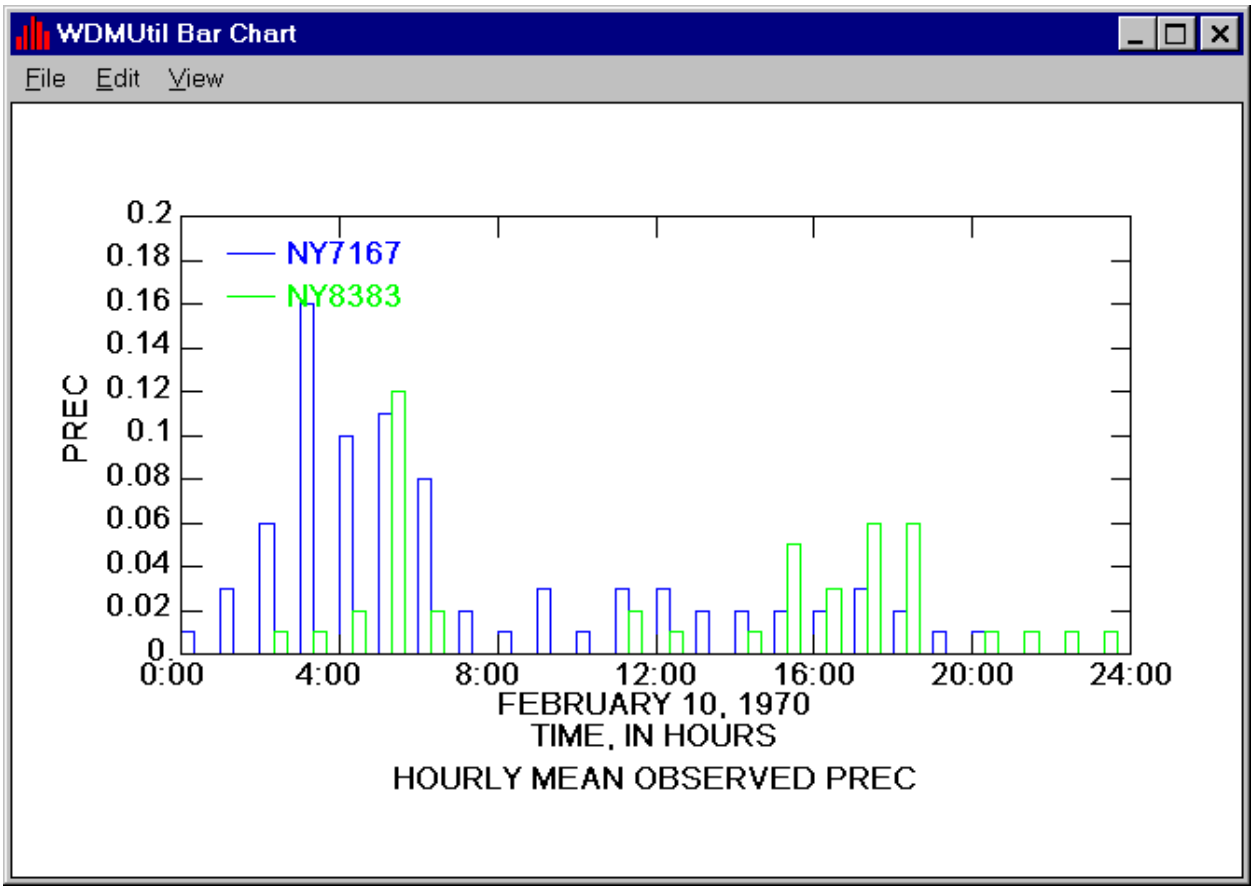
Standard

The Standard plot creates a time plot of the selected time series. All time series are plotted on an arithmetic scale on the left Y-axis by default. Once the plot is created, the axis types and which curves are plotted on them may be modified. A limit of 18 time series may be plotted on a single graph.



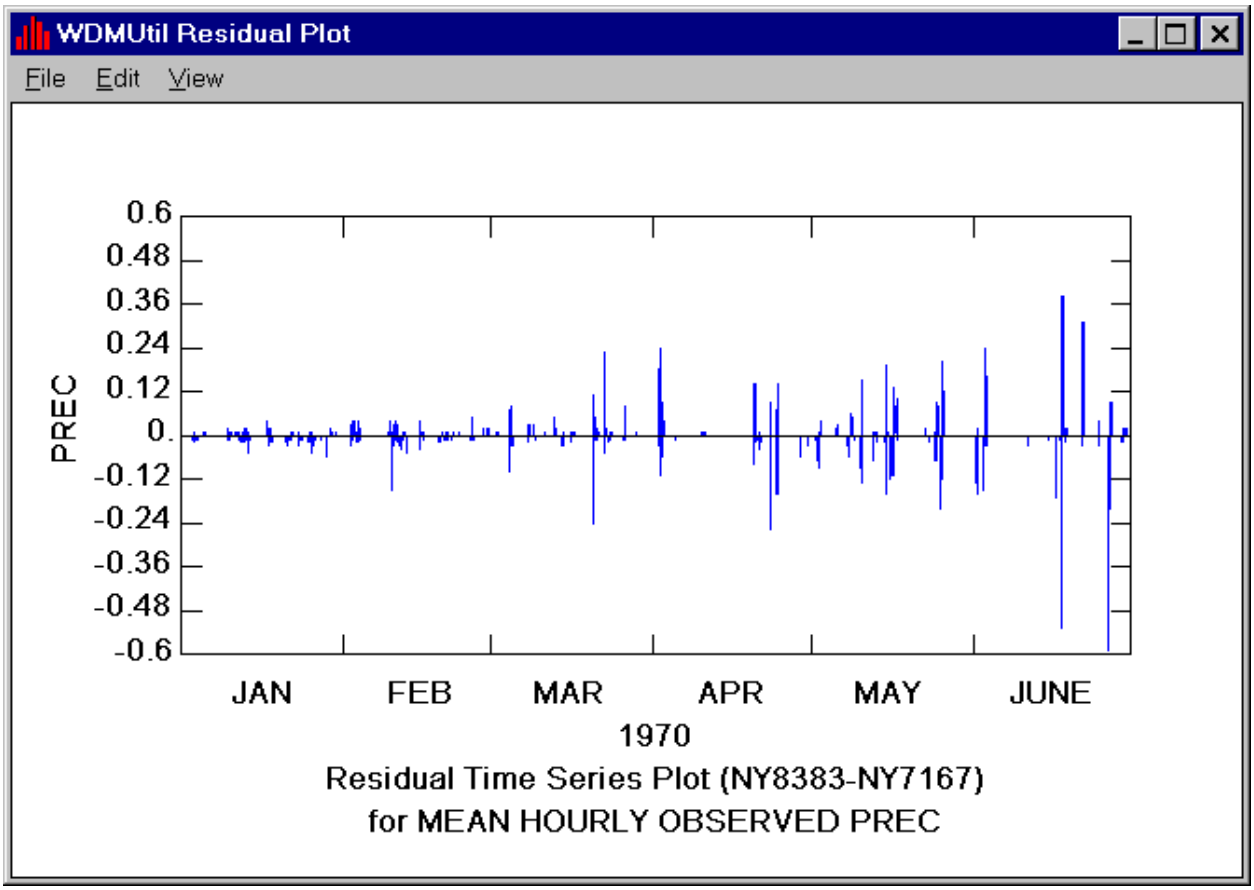
Bar Chart

The Bar Chart plot creates a time plot that shows the value from each time series side by side for each time interval. This plot is intended for close examination of values over a short period of time. The plot will lose any useful resolution for longer time spans (for example, greater than 50 time intervals).



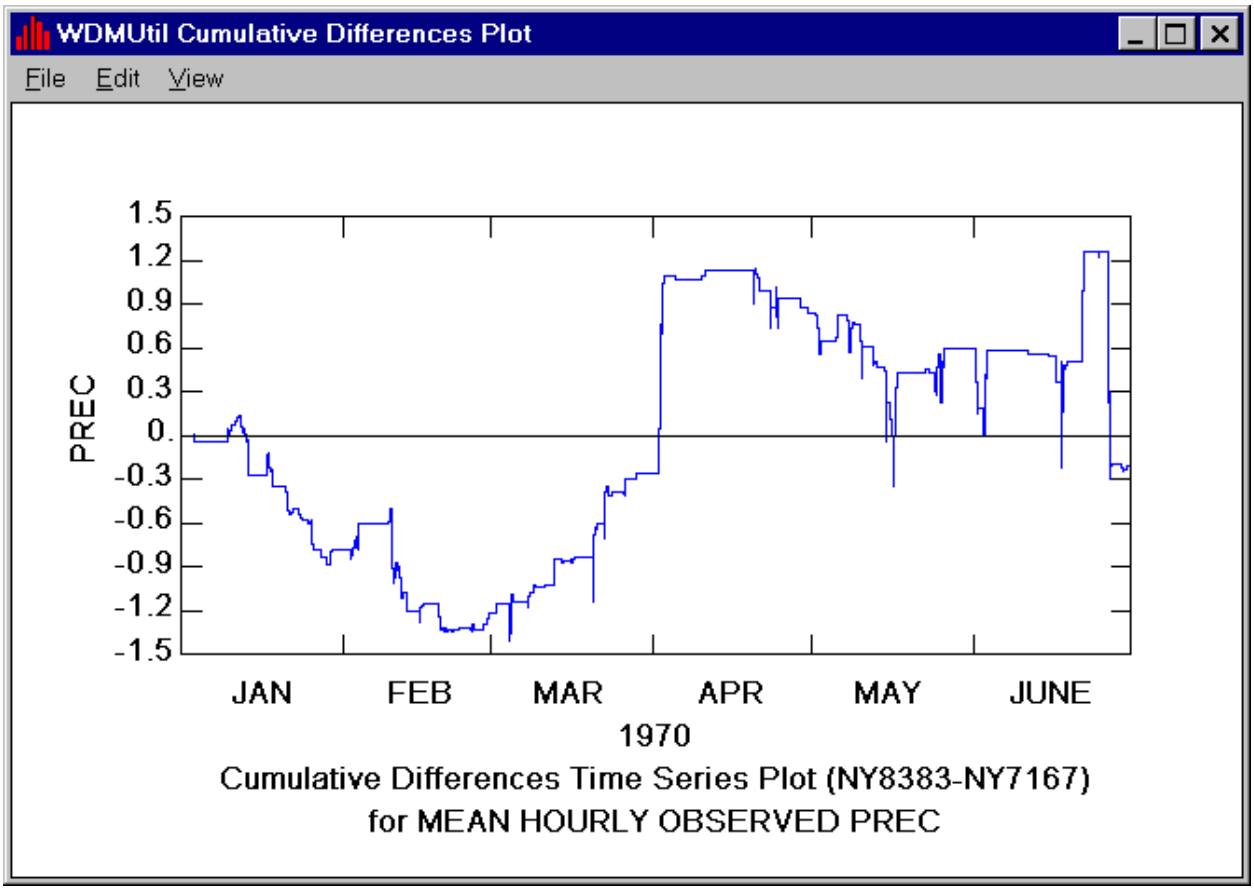
Residual

The Residual and Cumulative Differences plots create time plots of the difference between the second and first selected time series. The Residual plot displays the difference between the two time series at each time interval, whereas the Cumulative Differences plot displays the accumulated difference through time between the two time series. If more than two time series are selected, only the first two in the time-series list will be used for these plots.



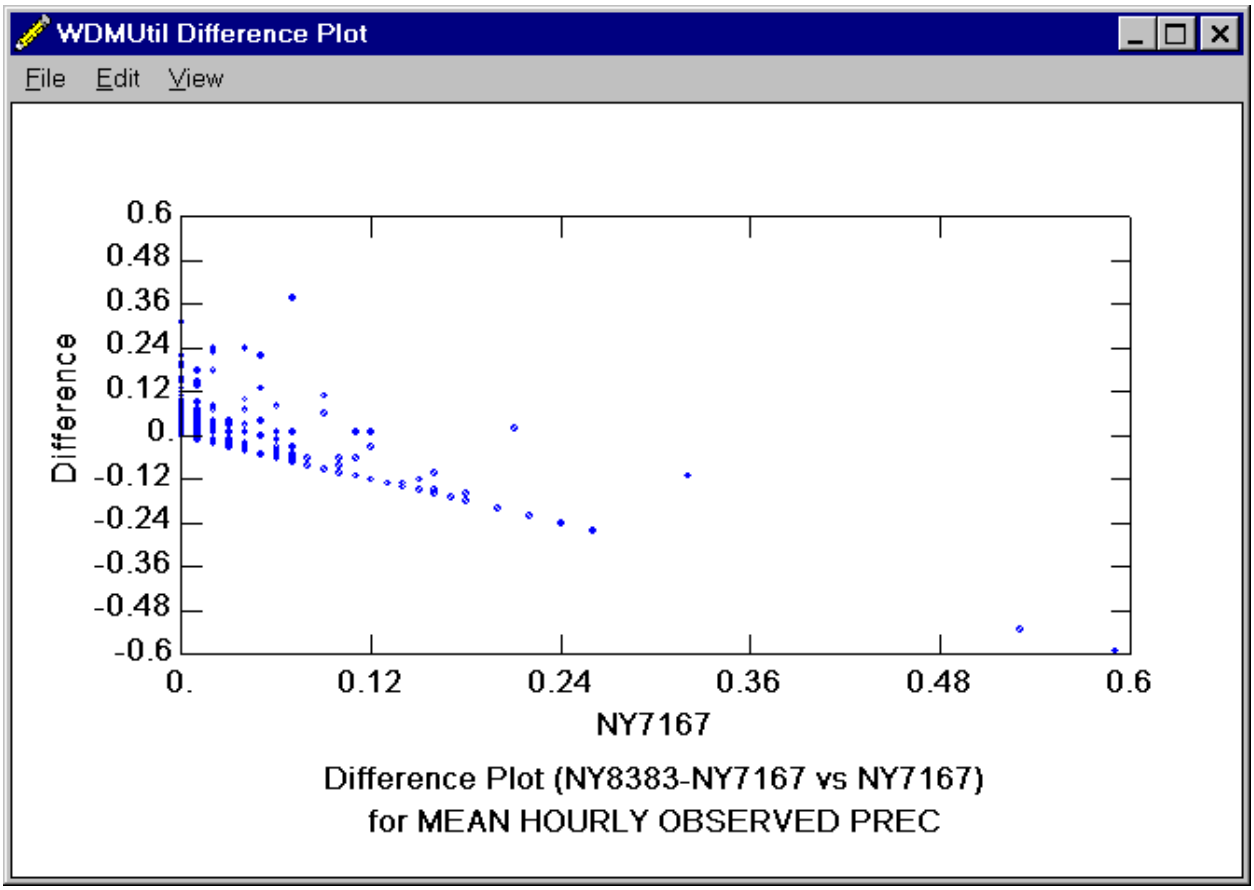
Cumulative

The Residual and Cumulative Differences plots create time plots of the difference between the second and first selected time series. The Residual plot displays the difference between the two time series at each time interval, whereas the Cumulative Differences plot displays the accumulated difference through time between the two time series. If more than two time series are selected, only the first two in the time-series list will be used for these plots.



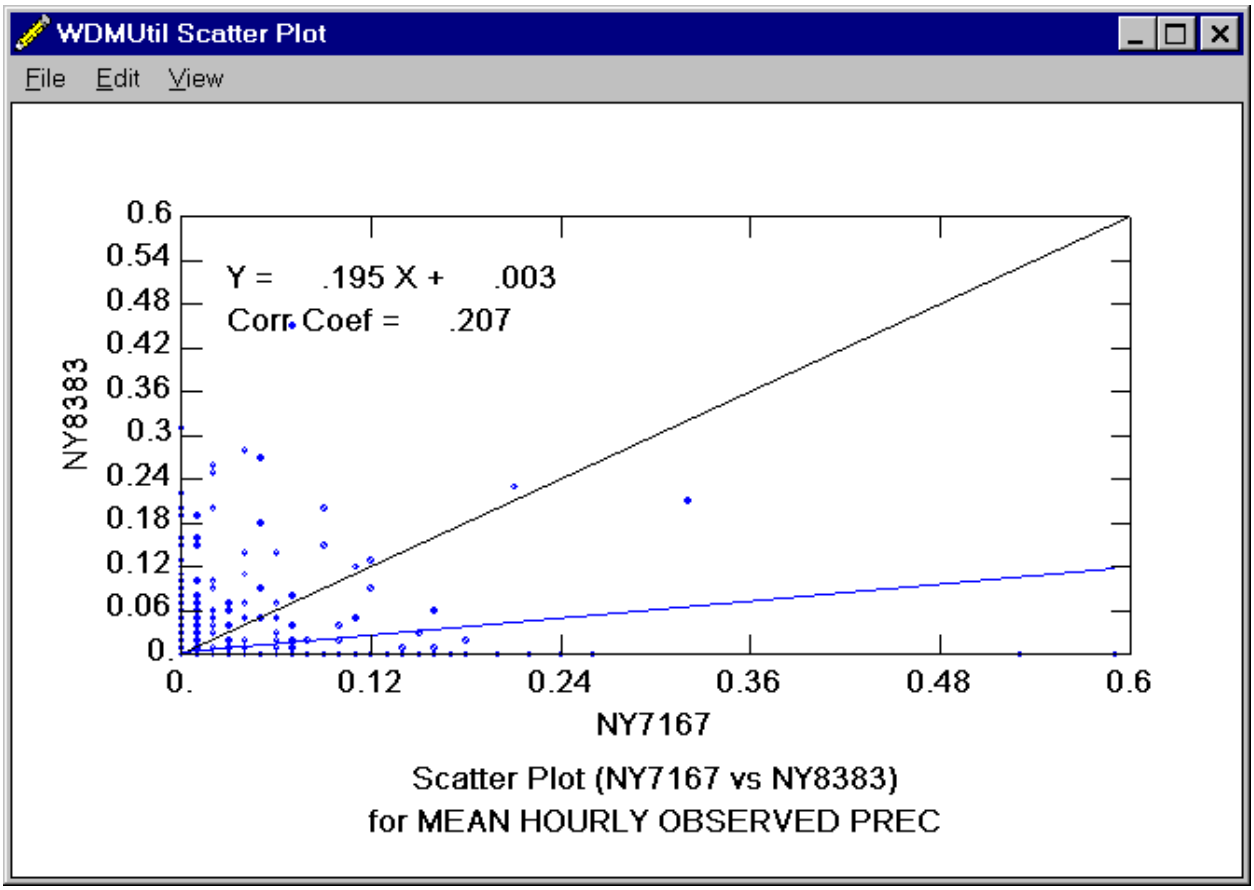
Difference

The Difference plot creates x-y plots using the first two selected time series. The difference between the two time series is plotted against the first time series. If more than two time series are selected, only the first two in the time-series list will be used for this plot.



Scatter

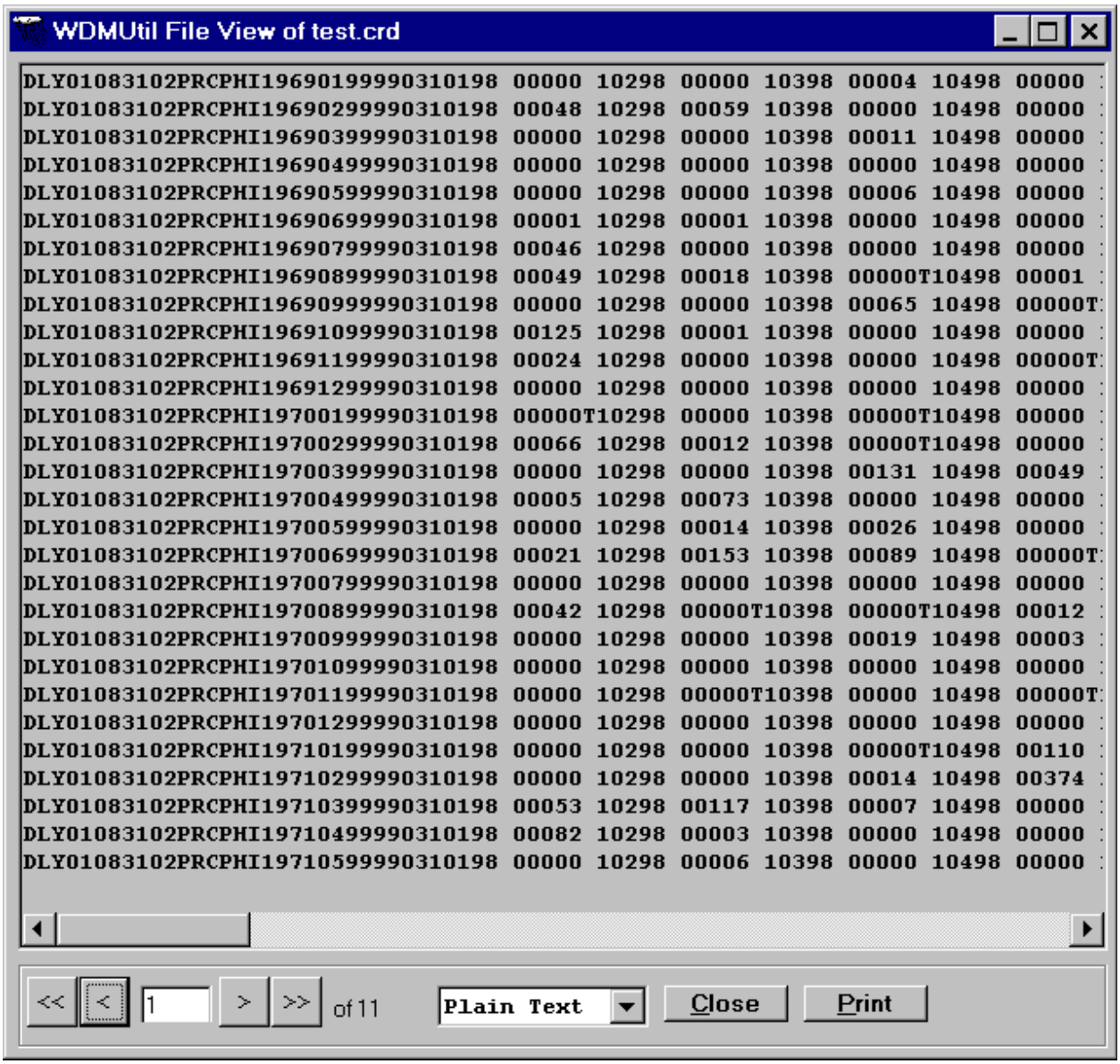
The Scatter plot creates x-y plots using the first two selected time series. The second time series is plotted against the first. There is an option to display the 45-degree and regression lines on the plot. If more than two time series are selected, only the first two in the time-series list will be used for this plot.



4.4 File View

The File View analysis tool is provided as a means of viewing any ASCII file from within WDMUtil.

Clicking on the File View button in the Analysis toolbar (or selecting the Analysis:File View menu item) will invoke the File Open common dialog, from which the user may specify the file to be viewed. After specifying the file name, the File View form will appear with the file text in a text box.



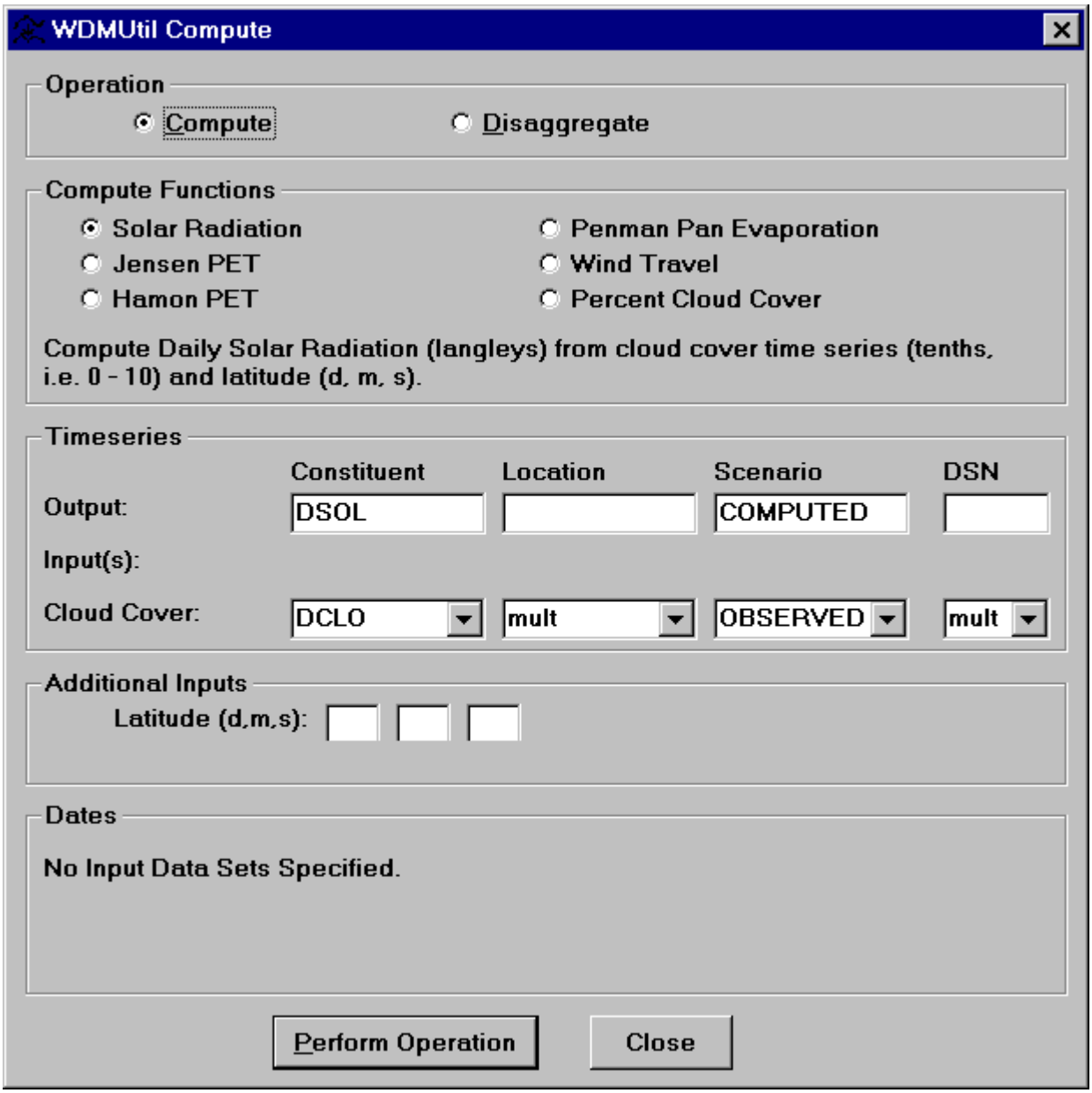
The File View form displays files one page at a time. At the bottom of the form is a set of buttons and a text box that are used to move through the file. The buttons are used to move forward or backward through the file. The text box is used to enter a specific page number to which to move. The field to the right of the buttons displays the total number of pages in the file. An additional list at the bottom of the form allows the user to select the format in which to view the file. The Plain Text option will fill each page with the maximum amount of text without using vertical scroll bars. The FORTRAN Output option will perform in this manner also with the exception that a new page will be formed whenever a FORTRAN carriage control character for new page is encountered. Although options for viewing in Binary and ESRI Shape File format exist, they are not used in WDMUtil. This file can be printed using the ‘Print’ button. The ‘Close’ button removes this form.

5 Transforming Data

WDMUtil contains two methods of transforming meteorological time-series data: Computing and Disaggregating. New data may be computed using a suite of algorithms that estimate various meteorological constituents based on existing meteorological data. New data may also be disaggregated from a daily time step to an hourly time step using the existing daily values and other associated parameters.

It is common for locations that are not near a large airport (where data collection tends to be more complete) to have a limited amount of meteorological data collected. These transformation tools provide alternative methods for developing the meteorological constituents needed for use in BASINS.

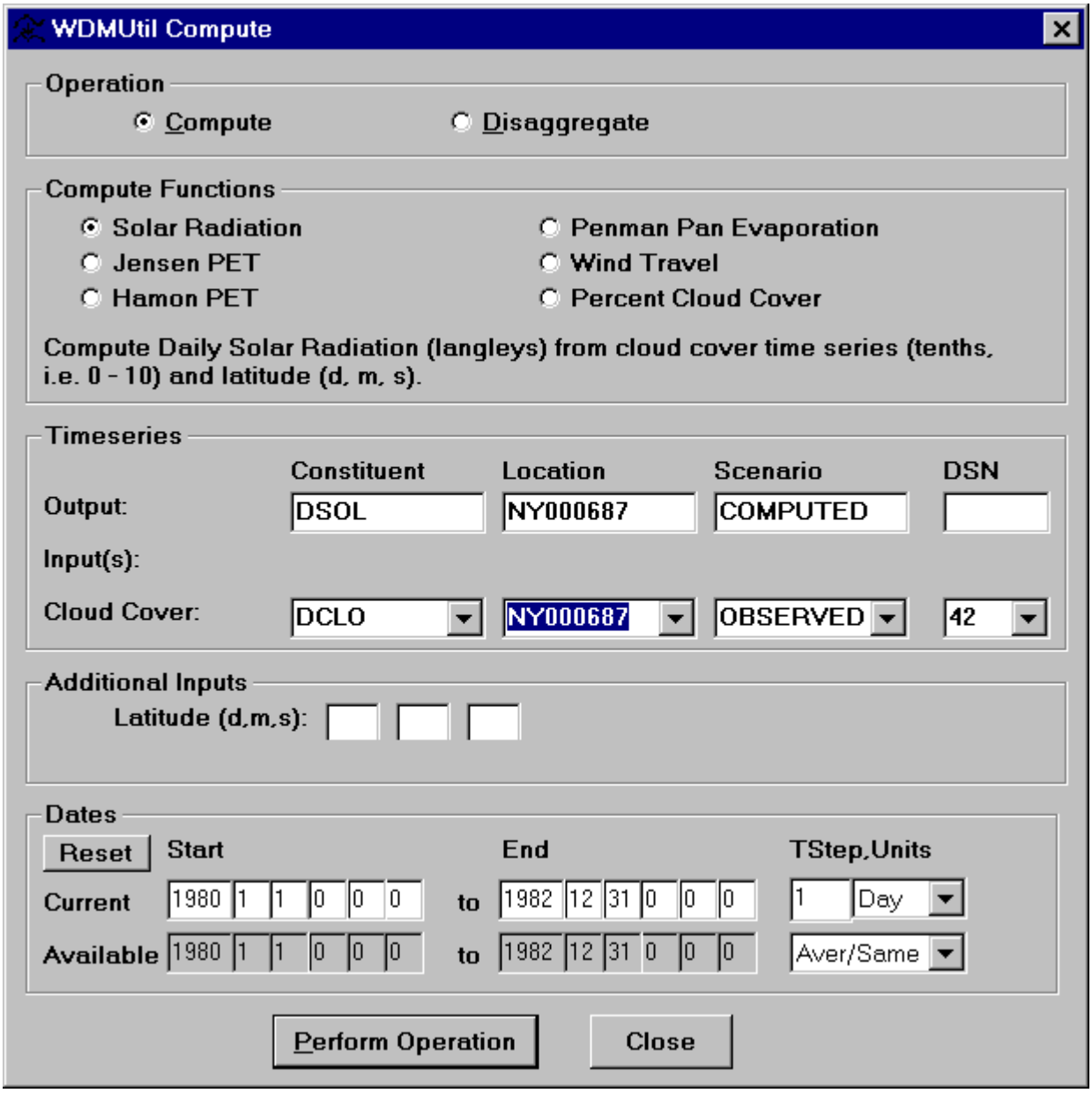
The user interface for the various compute and disaggregate options has a consistent look and feel.



The Operation frame is used to specify whether the user wants to Compute or Disaggregate. The next frame is named either Compute or Disaggregate Functions and contains the available compute or disaggregate functions, depending on which type of operation is being performed.

The Timeseries frame is used to specify input and output data sets needed for the operation. The number and types of input data sets needed varies from one operation to another. Each input data set will have a row containing a descriptive label, lists of available constituents, locations, and scenarios, and a list of available data-set numbers. With each selection made in the lists, remaining lists are updated to contain only those data sets that match the current selections. For example, if the DCLO (daily cloud cover) item is selected from the Constituent list, the Location, Scenario, and DSN lists are updated to contain only items from data sets which have DCLO as the constituent.

The ‘mult’ displayed in the Location list indicates that there is more than one location that has a DCLO data set. The OBSERVED displayed in the Scenario list indicates that there are only OBSERVED data sets for the DCLO constituent. The ‘mult’ displayed in the DSN list indicates that there are still multiple data sets available for the selections made so far. If one of the available locations is now selected, a unique data set will be defined.



Note that there is now a number (42) displayed in the DSN list. This indicates that a unique data set has been defined through the selections made in the Constituent, Location, and Scenario lists. The Constituent, Location, and Scenario lists are provided to remove the burden of having to remember data-set numbers. However, if the user knows the number of the needed input data set, they may select the

number from the DSN list at any time. The Constituent, Location, and Scenario lists will be updated to reflect the selected data set.

As selection of input data sets is performed, updates to the output data set's specifications are made. For example, when a unique location is selected for the input data set, this is entered as the default location for the output data set. These defaults may be overwrote by the user. No default data-set number is specified by the program. A valid data-set number (between 1 and 9999) must be entered by the user to perform the operation. Existing data sets may be overwritten, but to assure desired data are not lost, the user will be prompted to confirm this action.

When the input data sets have been defined, the Dates frame is filled with the available period of record common to the input data sets. This period may be updated by the user and will define the period over which the operation will be performed.

The Additional Inputs frame contains miscellaneous inputs that are needed by some of the operations. These inputs must be properly defined before the operation may be performed. If an operation does not have any inputs other than time-series data sets, the Additional Inputs frame will not be displayed.

The 'Perform Operation' button starts the specified operation. All required fields will be checked for validity before the operation is performed. If these are all valid, the operation is performed, and a message indicates whether or not the operation was successful. If it was successful, the user is prompted to confirm that the new data should be stored on the WDM file in the specified output data set.

The 'Close' button will close the Compute form.

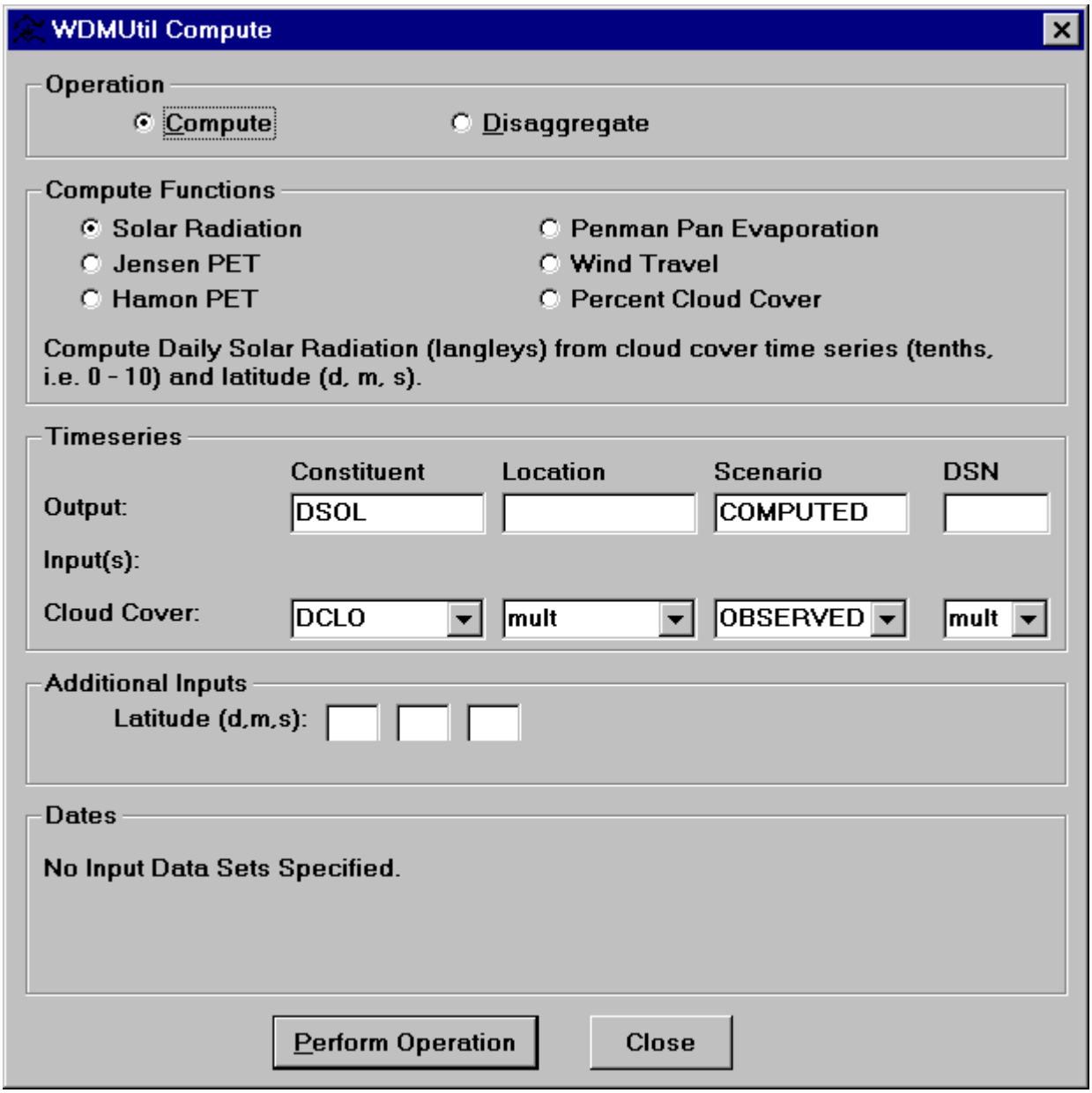
5.1 Compute

WDMUtil contains algorithms for computing Solar Radiation, Jensen PET, Hamon PET, Penman Pan Evaporation, Wind Travel, and Cloud Cover data. The suite of algorithms for computing these data requires varying numbers and types of existing meteoric data sets and associated parameters. The algorithms and data requirements may be found in the following sections that describe the different computations.

Solar Radiation (Compute)

This procedure computes the total daily solar radiation based on empirical curves of radiation as a function of latitude (Hamon et al, 1954). The inputs are latitude in degrees and daily cloud cover in tenths (ranges from 0 to 10). This method is limited to latitudes from 25 degrees N to 50 degrees N, but this limit is not enforced by the program. The output is total daily solar radiation at the surface in langleys.

The layout of the Compute screen for Solar Radiation computation appears as follows:



Summary

Inputs:

- Latitude (degrees, minutes, seconds)
- Daily cloud cover time series (tenths, i.e., 0 - 10)

Output:

- Daily solar radiation (langleys)

Jensen PET

This procedure generates daily potential evapotranspiration (inches) using a coefficient for the month, the daily average air temperature (F), a coefficient, and solar radiation (langleys/day). The computations are based on the Jensen and Haise (1963) formula.

```
      PET = CTS * (TAVF - CTX) * RIN

where
      PET  = daily potential evapotranspiration (in)
      CTS  = monthly variable coefficient
      TAVF = mean daily air temperature (F), computed from max-min
      CTX  = coefficient
      RIN  = daily solar radiation expressed in inches of evaporation

      RIN = SWRD/(597.3 - (.57 * TAVC)) * 2.54

where
      SWRD = daily solar radiation (langleys)
      TAVC = mean daily air temperature (C)
```

The following is abstracted from the PRMS manual (Leavesley, et al., 1983): As with the Hamon procedure, the Jensen-Haise procedure tends to underestimate winter PET; therefore, monthly variable CTS coefficients are included. Values of CTS and CTX for the warmer months can be estimated using regional air temperature, elevation, vapor pressure, and vegetation data (Jensen et al. 1969). For aerodynamically rough crops (assumed to include forests), CTS can be computed for the watershed by:

```
      CTS = 1/[C1 + (13.0 * CH)]

where
      C1 = an elevation correction factor
      CH = humidity index

      C1 = 68.0 - [3.6 * E1/1000]

where
      E1 = median elevation of the watershed (ft)

      CH = 50/(e2 - e1)

where
      e2 =  saturation vapor pressure (mb) for the mean maximum
            air temperature for the warmest month of the year

      e1 =  saturation vapor pressure (mb) for the mean minimum
            air temperature for the warmest month of the year
```

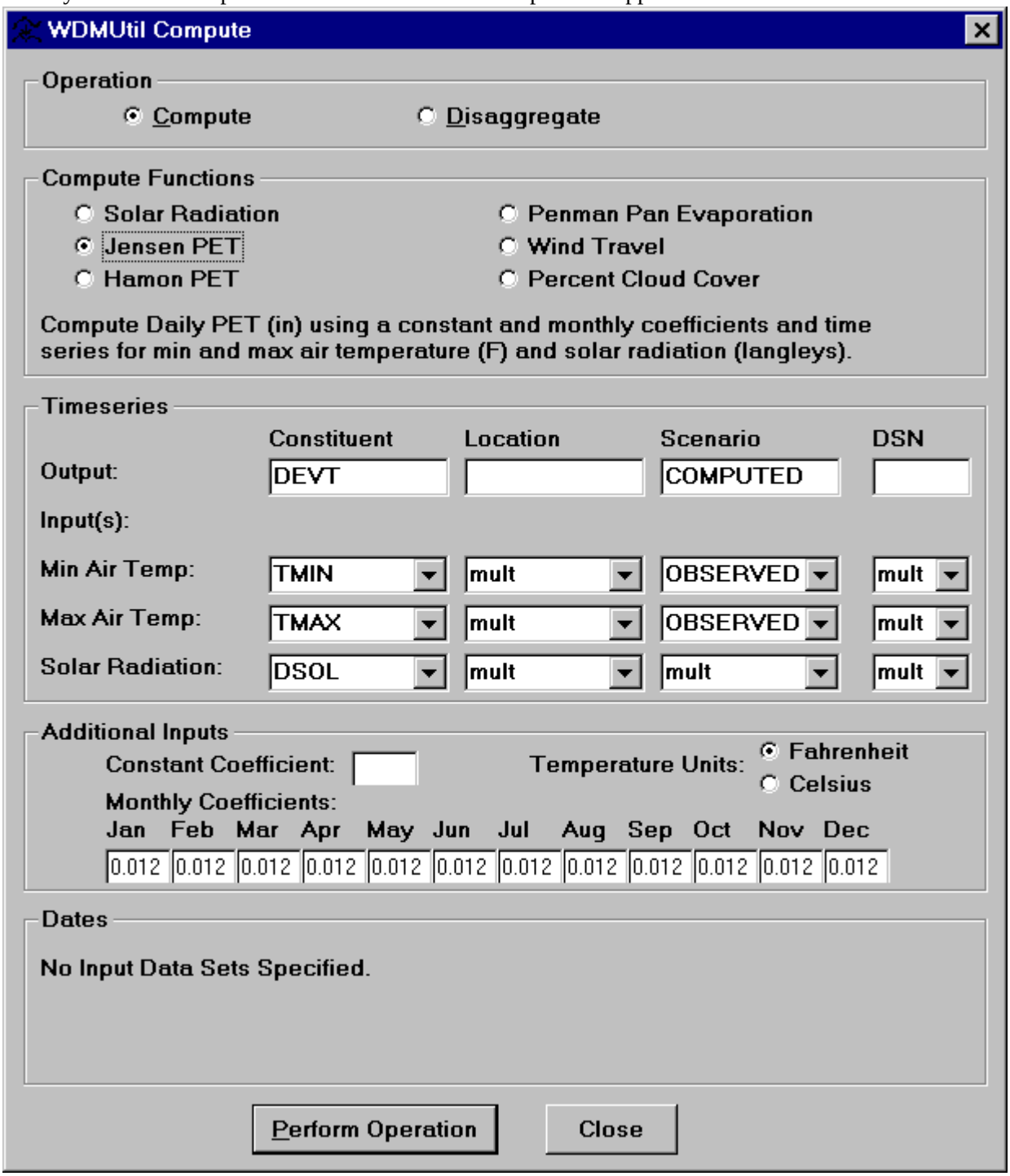
CTX is computed for each land segment as:

```
      CTX = 27.5 - 0.25 * (e2 - e1) - (E2/1000)
```

where

E2 = median elevation of the land segment (ft)

The layout of the Compute screen for Jensen PET computation appears as follows:



Summary

Inputs:

- Maximum daily air temperature time series (F or C)
- Minimum daily air temperature time series (F or C)
- Total daily solar radiation time series (langleys)
- Monthly variable coefficient - CTS
- Constant coefficient - CTX

Output:

- Daily potential evapotranspiration (inches)

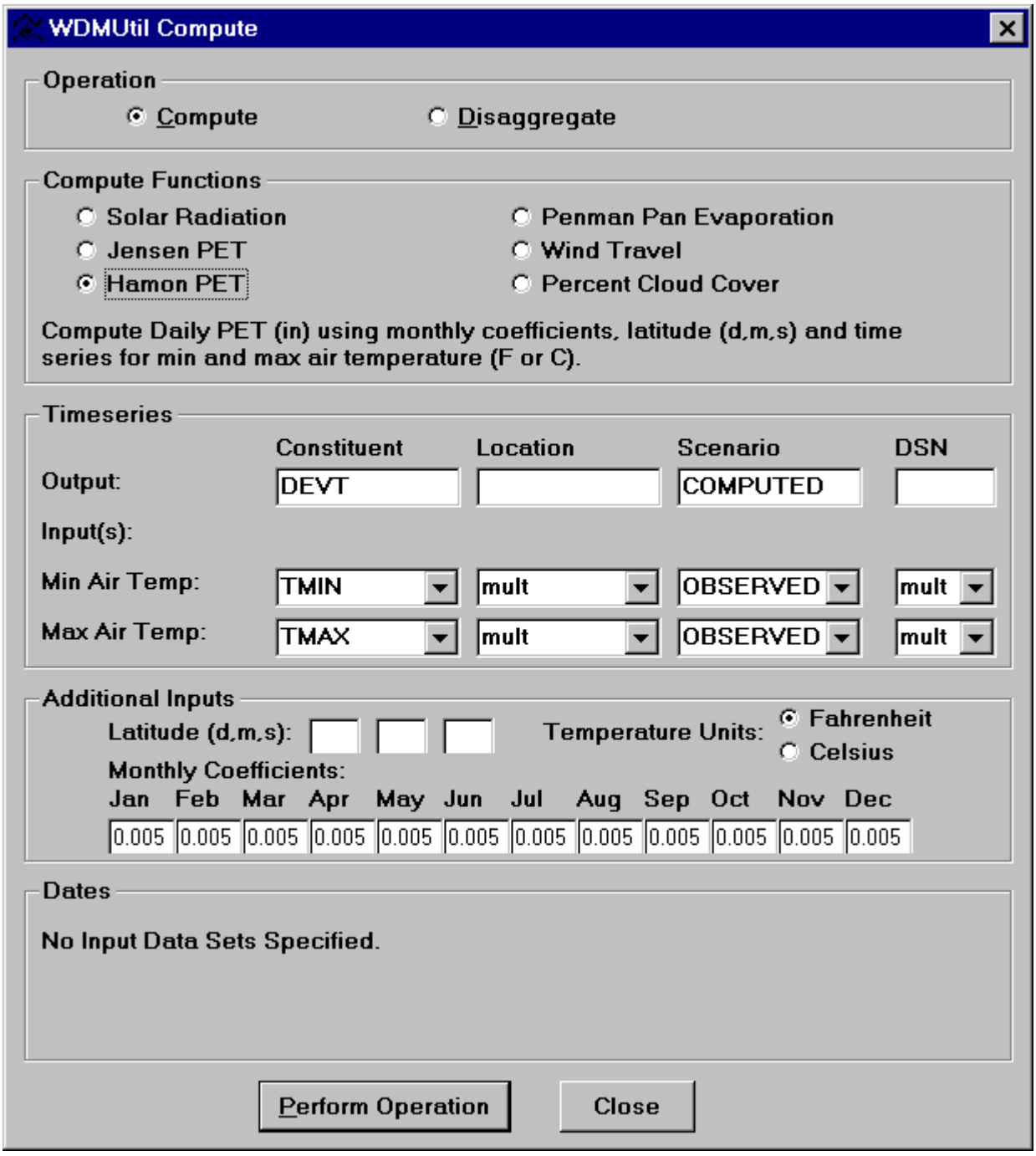
Hamon PET

This method generates daily potential evapotranspiration (inches) using air temperature, a monthly variable coefficient, the number of hours of sunshine (computed from latitude), and absolute humidity (computed from air temperature). The computations are based on the Hamon (1961) formula.

```
      PET = CTS * DYL * DYL * VDSAT

where
      PET   = daily potential evapotranspiration (in)
      CTS   = monthly variable coefficient
      DYL   =     possible hours of sunshine, in units of 12 hours,
              computed as a function of latitude and time of year
      VDSAT = saturated water vapor density (absolute humidity)
              at the daily mean air temperature (g/cm3)

      VDSAT = (216.7 * VPSAT)/(TAVC + 273.3)

where
      VPSAT = saturated vapor pressure at the air temperature
      TAVC  = mean daily air temperature,
              computed from the daily max-min data (C)

      VPSAT = 6.108 * EXP((17.26939 * TAVC)/(TAVC + 237.3))
```

Hamon (1961) suggests a constant value of 0.0055 for CTS. However, this has been found to underestimate PET in some areas, especially for winter months. Therefore, monthly values can be specified.

The layout of the Compute screen for Hamon PET computation appears as follows:


WDMUtil Compute
Operation
Compute
Disaggregate
Compute Functions
Solar Radiation
Jensen PET
Hamon PET
Penman Pan Evaporation
Wind Travel
Percent Cloud Cover
Compute Daily PET (in) using monthly coefficients, latitude (d,m,s) and time series for min and max air temperature (F or C).
Timeseries
Constituent
Location
Scenario
DSN
Output:
DEVT
COMPUTED
Input(s):
Min Air Temp:
TMIN
mult
OBSERVED
mult
Max Air Temp:
TMAX
mult
OBSERVED
mult
Additional Inputs
Latitude (d,m,s):
Temperature Units:
Fahrenheit
Celsius
Monthly Coefficients:
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005
Dates
No Input Data Sets Specified.
Perform Operation
Close

Summary

Inputs:

- Maximum daily air temperature time series (F or C)
- Minimum daily air temperature time series (F or C)
- Latitude (D,M,S)
- Monthly variable coefficient

Output:

- Daily potential evapotranspiration (inches)

Penman Pan Evaporation

This procedure estimates daily pan evaporation (inches) using daily average air temperature (F), dewpoint (F), wind movement (miles/day), and solar radiation (langleys/day). The method is that of Kohler, Nordensen, and Fox (1955), and it is based on the Penman (1948) formula; the following description is abstracted from Hydrocomp (1977):

$$E = (Q*DEL + Ea*GAM)/(DEL + GAM) \quad (1)$$

where

E = pan evaporation
Q = net radiation exchange
DEL = slope of the saturation vapor pressure curve at the air temperature
GAM = 0.0105 inches Hg/deg F (defined by Bowen's Ratio)
Ea = pan evaporation (assuming air temperature equals water temperature)

To express the above equation in terms of available meteorological data, empirical curve fitting of data points is used. An empirical expression for Q*DEL, which can be treated as a single parameter, is

$$Q*DEL = \exp[(Ta - 212)\ (0.1024 - 0.01066 \ln R)] - 0.000 \quad (2)$$

where

Ta = air temperature (F)
R = daily solar radiation (langleys)

An expression for Ea is

$$Ea = (0.37 + 0.0041\ Up) * (es - ea)^{**}0.88 \quad (3)$$

where

(es - ea) = vapor pressure deficit between surface and dewpoint temperature and
Up = total daily wind movement (miles)

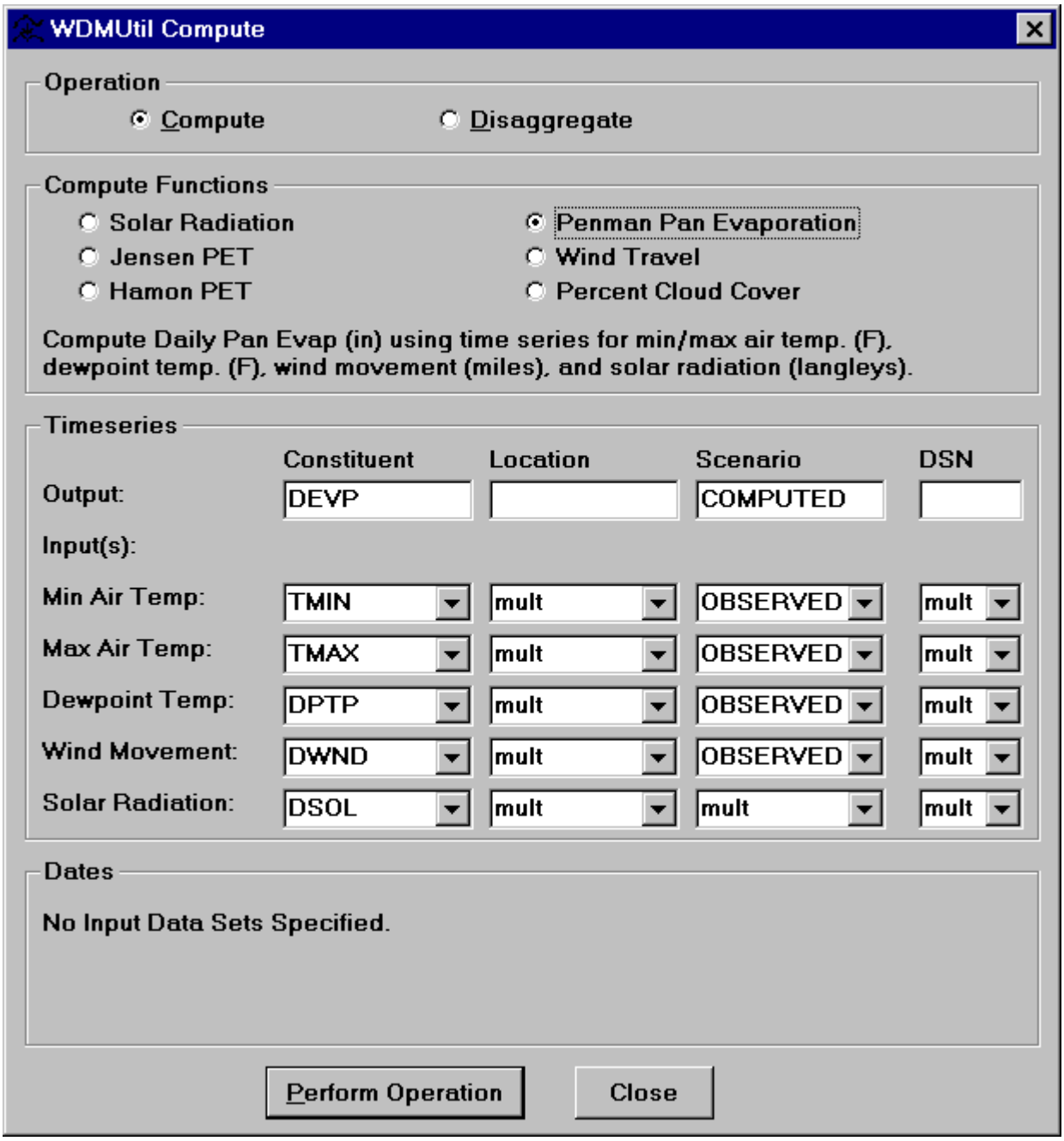
The Clausius-Clapeyron equation can be used to express e, the vapor pressure, and DEL, the slope of the saturation vapor pressure curve at air temperature Ta:

$$e = \exp\{[-7482.6/(Ta + 398.36)] + 15.674\} \quad (4)$$

$$DEL = [7482.6/Ta+398.36)^{**}2]\ \exp[15.674-7482.6/(Ta+398.36)] \quad (5)$$

To calculate evaporation, the procedure uses Eqn 1. Parameters needed for the evaluation of Eqn 1 are found using Eqns 2-5. Air temperature is estimated as the average of maximum and minimum daily temperature. If dewpoint temperatures are not available, minimum daily temperatures can be substituted.

The layout of the Compute screen for Penman Pan Evaporation computation appears as follows:


WDMUtil Compute
Operation
Compute
Disaggregate
Compute Functions
Solar Radiation
Jensen PET
Hamon PET
Penman Pan Evaporation
Wind Travel
Percent Cloud Cover
Compute Daily Pan Evap (in) using time series for min/max air temp. (F), dewpoint temp. (F), wind movement (miles), and solar radiation (langleys).
Timeseries
Constituent
Location
Scenario
DSN
Output:
DEVP
COMPUTED
Input(s):
Min Air Temp:
TMIN
mult
OBSERVED
mult
Max Air Temp:
TMAX
mult
OBSERVED
mult
Dewpoint Temp:
DPTP
mult
OBSERVED
mult
Wind Movement:
DWND
mult
OBSERVED
mult
Solar Radiation:
DSOL
mult
mult
mult
Dates
No Input Data Sets Specified.
Perform Operation
Close

Summary

Inputs:

- Maximum daily air temperature time series (F)
- Minimum daily air temperature time series (F)
- Average daily dewpoint temperature time series (F)
- Total daily wind movement time series (miles)
- Total daily solar radiation time series (langleys)

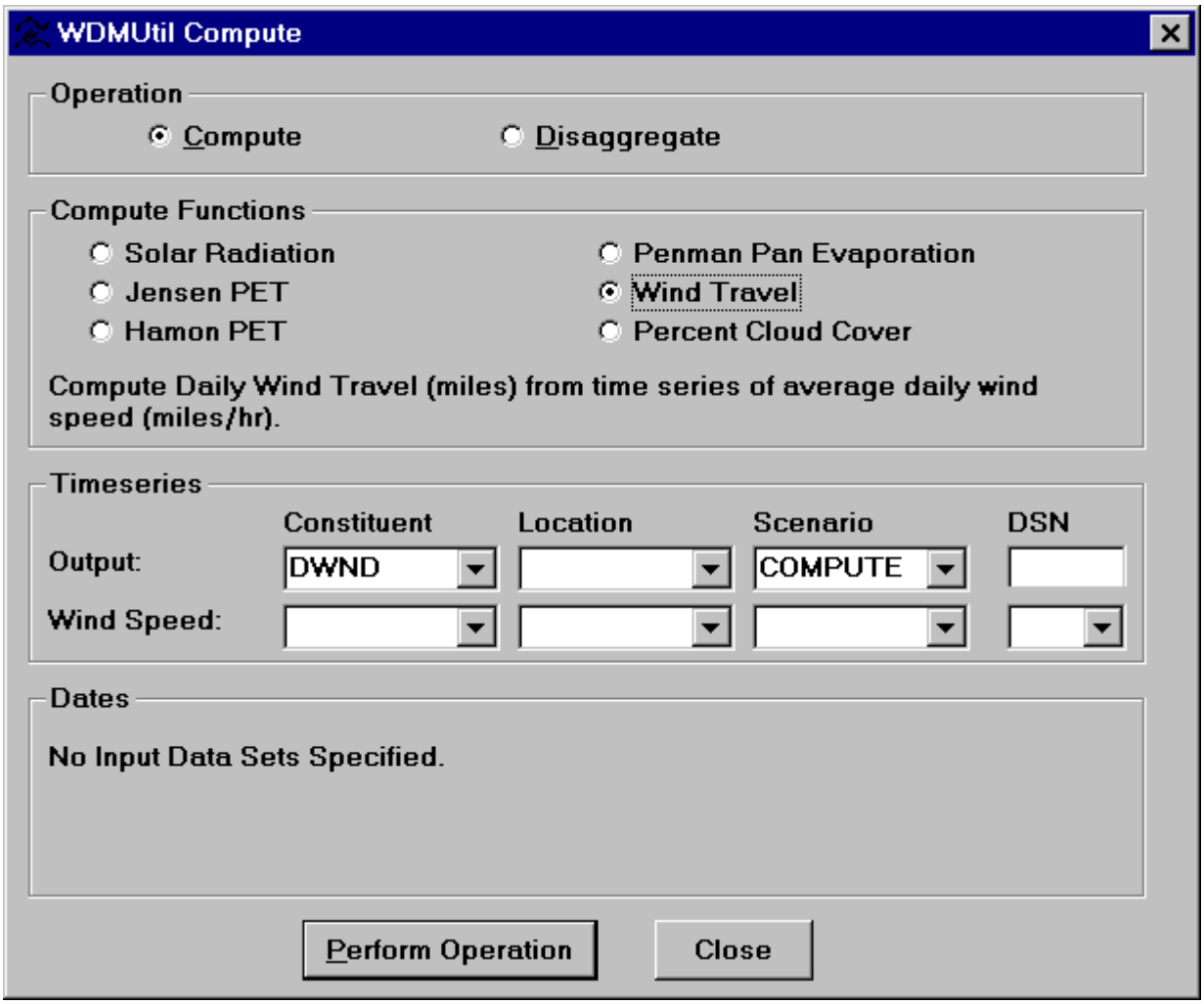
Output:

- Daily pan evaporation (inches)

Wind Travel (Compute)

This procedure computes total daily wind travel, in miles, from average daily wind speed, in miles per hour. The average daily wind speed is multiplied by 24 to generate the total daily wind travel.

The layout of the Compute screen for Wind computation appears as follows:



Summary

Inputs:

- Average Daily Wind Speed (mph)

Outputs:

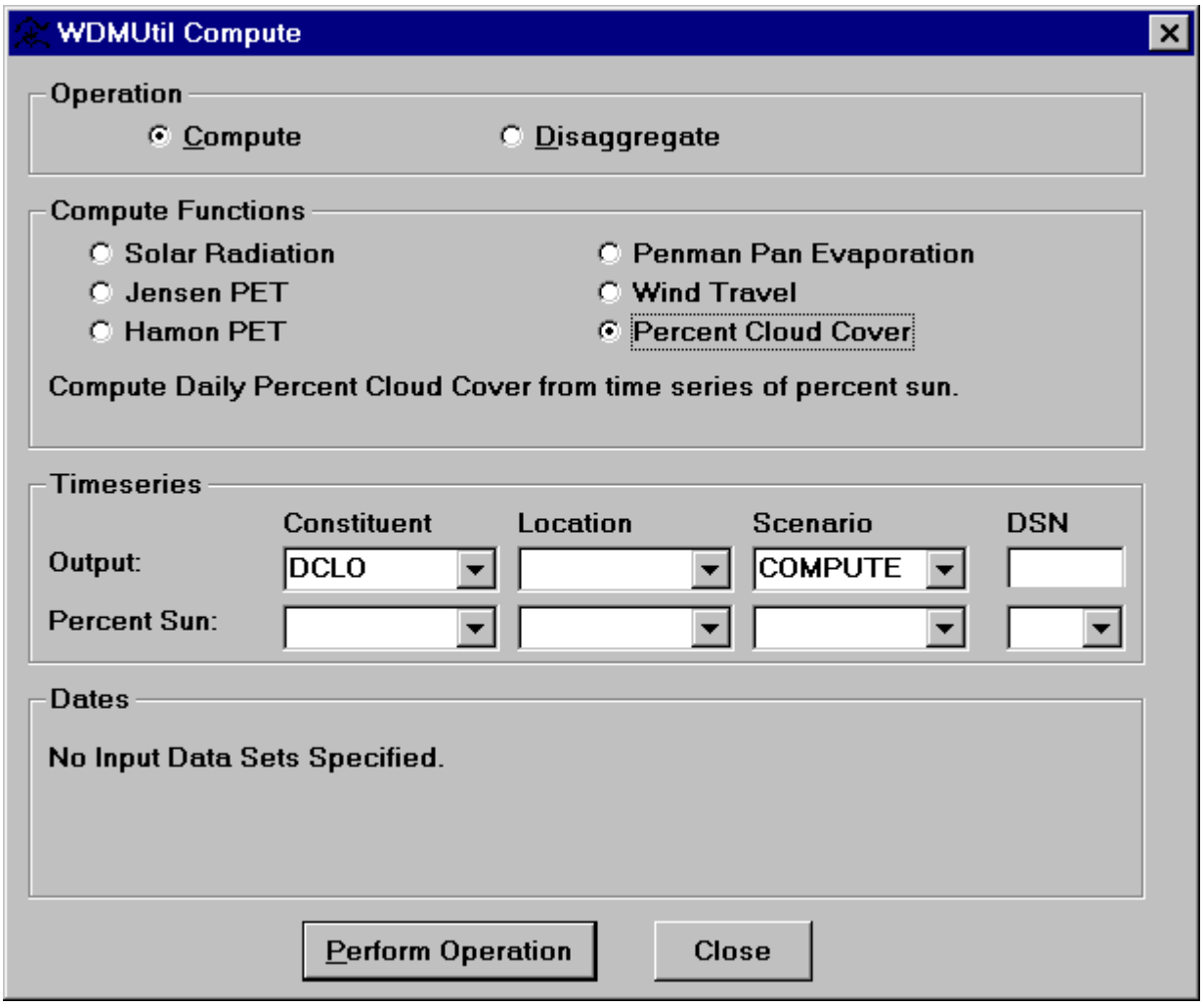
- Total Daily Wind Travel (miles)

Cloud Cover

This procedure computes daily percent cloud cover from daily percent sunshine. The relationship between these two constituents is extracted from the algorithms developed by Hamon, Weiss, and Wilson (1954) for Solar Radiation. Specifically, the relationship is as follows:

```
      CC = 100 * (1 - PSS/100)**0.6

where
      CC = percent cloud cover
      PSS = percent sunshine
```

The layout of the Compute screen for Cloud Cover computation appears as follows:



Summary

Inputs:

- Percent Sunshine (0 - 100)

Outputs:

- Percent Cloud Cover

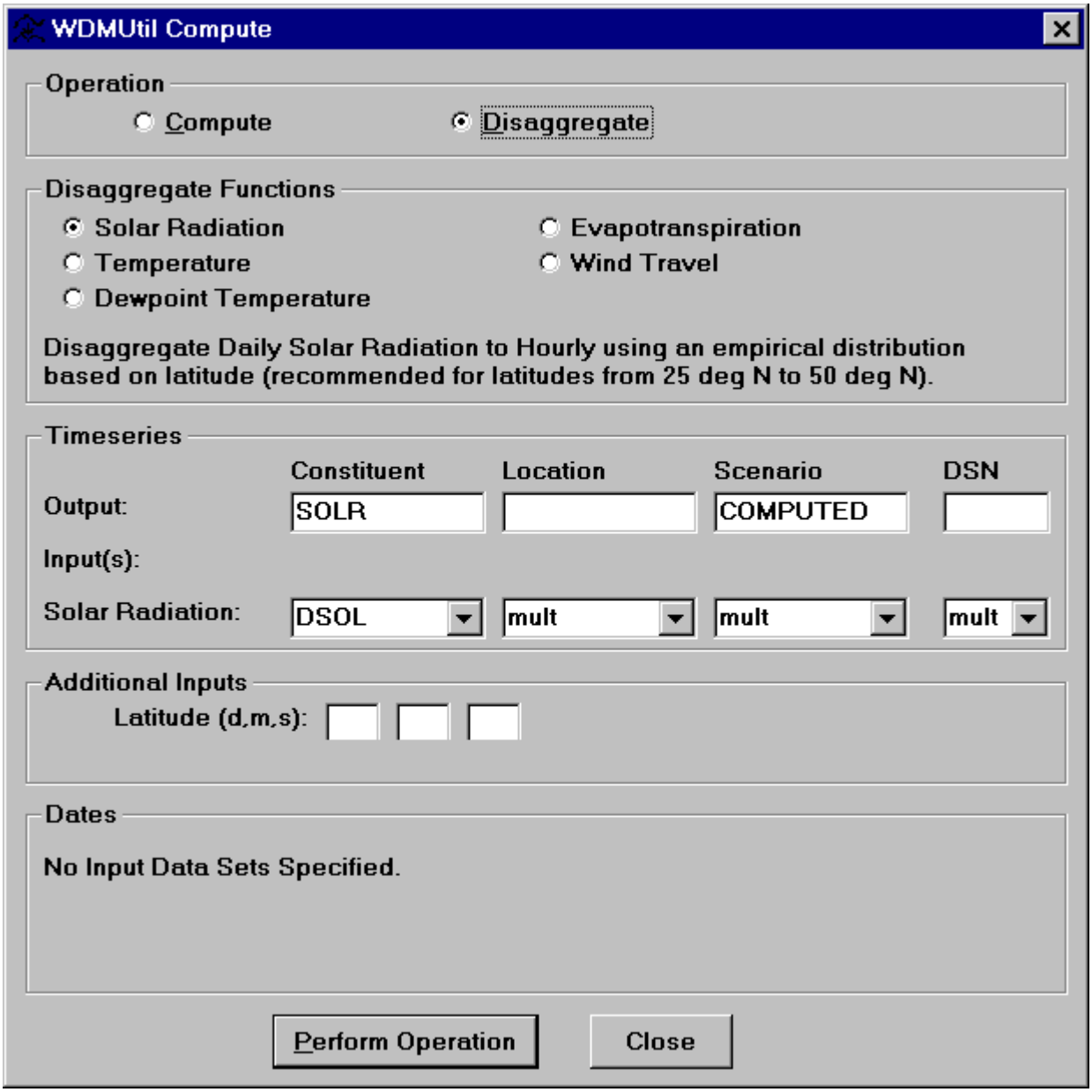
5.2 Disaggregate

WDMUtil contains algorithms for disaggregating Solar Radiation, Temperature, Dewpoint Temperature, Evapotranspiration, and Wind data. The suite of algorithms for disaggregating these data requires varying types of existing meteorological data sets and associated parameters. The algorithms and data requirements may be found in the following sections that describe the different disaggregations.

Solar Radiation

This procedure distributes daily solar radiation to hourly values by assuming an empirical distribution over daylight hours that are computed from latitude and time of year. It is limited to latitudes from 25 degrees N to 50 degrees N, but this limit is not enforced by the program. It is an empirical method based on work by Hamon et al. (1954).

The layout of the Compute screen for Solar Radiation disaggregation appears as follows:



Summary

Inputs:

- Daily solar radiation (langleys or any units)
- Latitude (D,M,S)

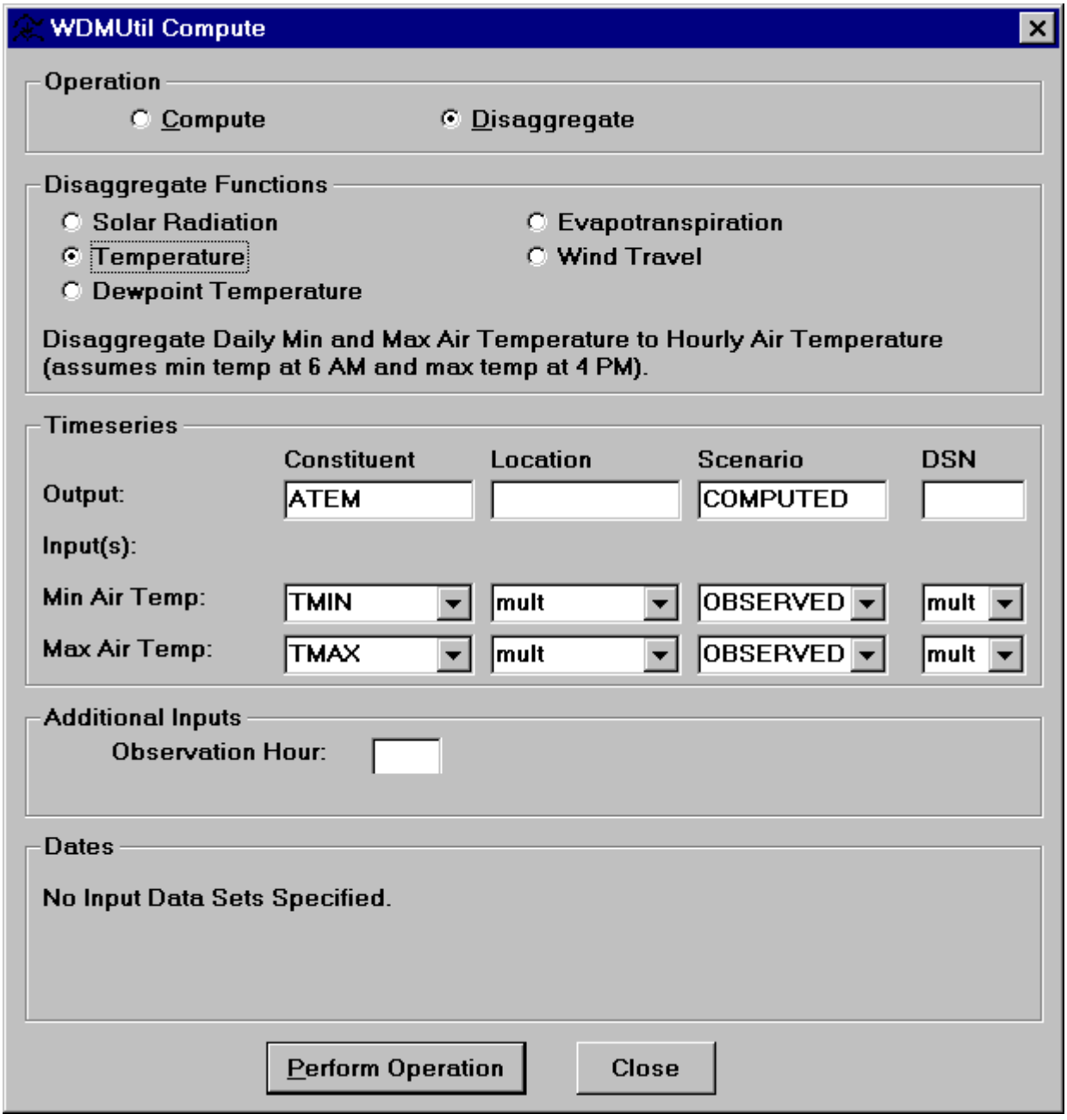
Output:

- Hourly solar radiation (same units as input)

Temperature

This procedure distributes daily max-min temperatures to hourly values; it assumes the minimum occurs at 6 AM and the maximum occurs at 4 PM.

The layout of the Compute screen for Temperature disaggregation appears as follows:



Summary

Inputs:

- Maximum daily air temperature (F)
- Minimum daily air temperature (F)
- Observation hour (1-24)

  This is the hour at which these max and min temperatures are recorded. If this hour is 17 - 24, then both the input max and min actually occurred on
  that day. If the hour is 6 - 16, then the input max actually occurred on the previous day. If the hour is 1 - 5, then both the input max and min actually occurred on the previous day.

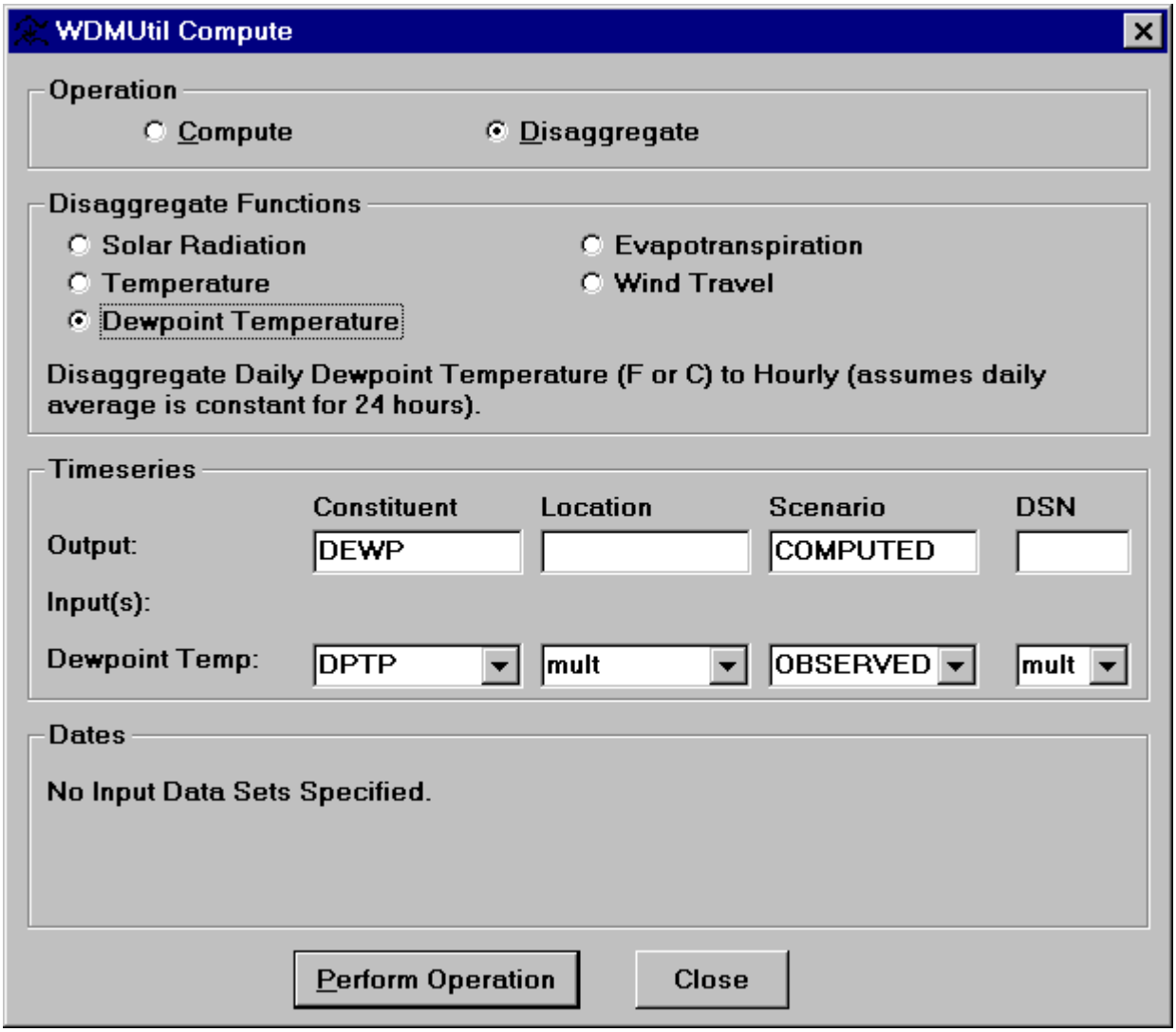
Output:

- Hourly air temperature (F)

Dewpoint Temperature

This procedure distributes average daily dewpoint temperature to hourly values. It assumes that the daily average is constant over the 24 hour period.

The layout of the Compute screen for Dewpoint Temperature disaggregation appears as follows:



Summary

Inputs:

- Average Daily Dewpoint Temperature (F or C)

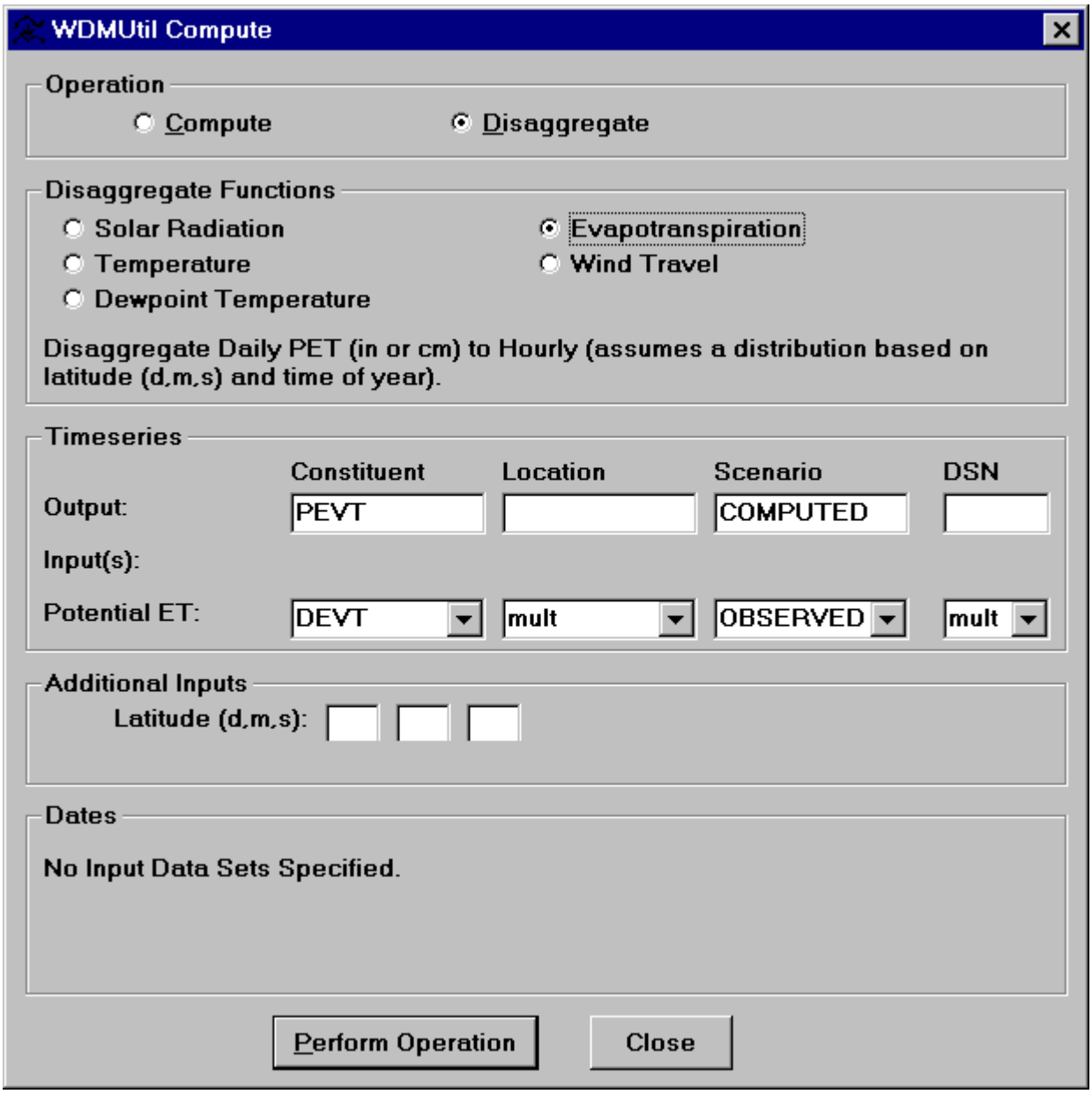
Outputs:

- Hourly Dewpoint Temperature (F or C)

Evapotranspiration

This procedure distributes daily evapotranspiration to hourly values; it assumes a distribution based on latitude and time of year.

The layout of the Compute screen for Evapotranspiration disaggregation appears as follows:



Summary

Inputs:

- Daily PET (inches or any units)
- Latitude (D,M,S)

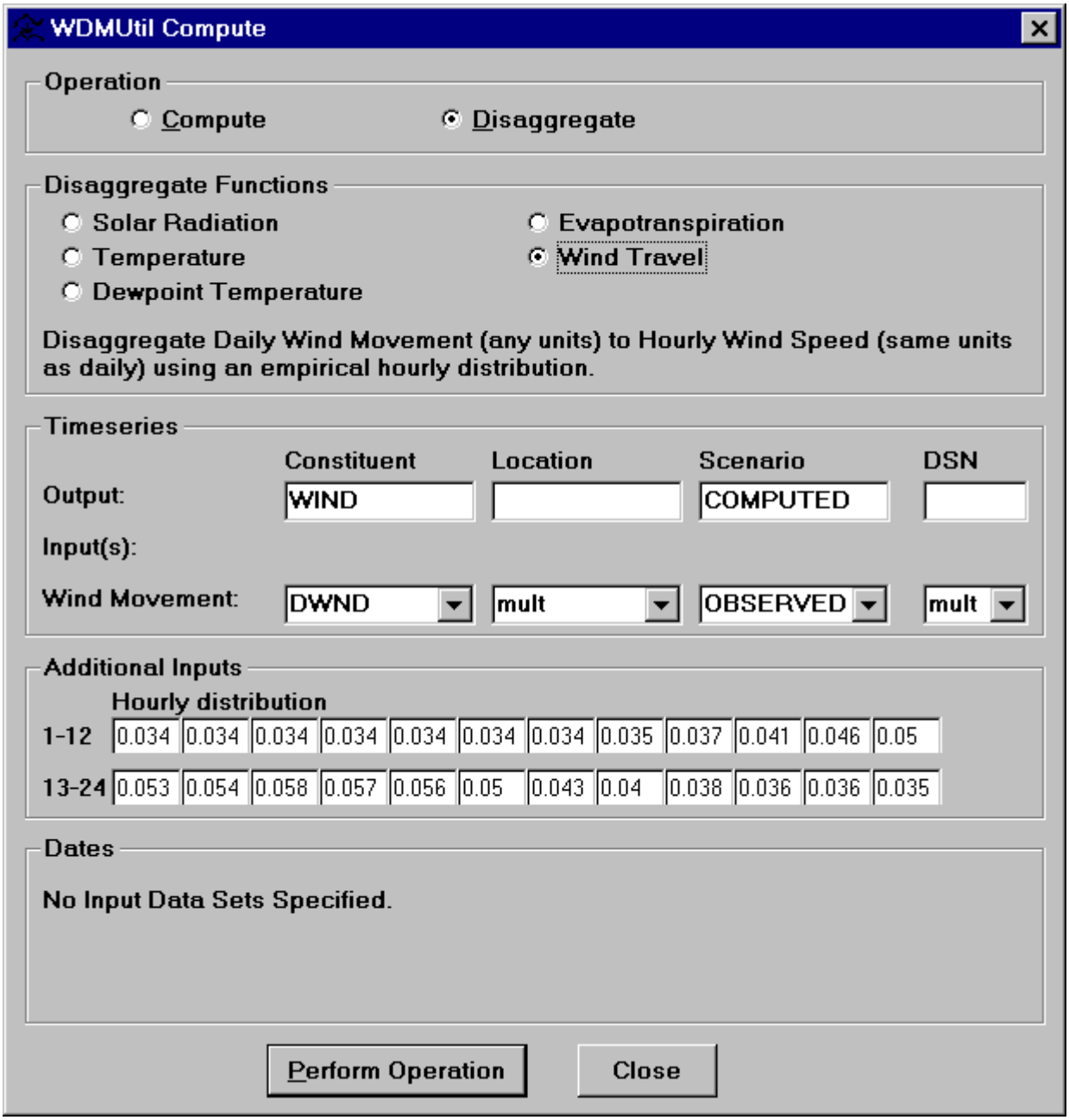
Output:

- Hourly PET (same units as input)

Wind Travel

This procedure distributes daily wind movement to hourly values; it allows the user to adjust the default empirical hourly distribution.

The layout of the Compute screen for Wind Travel disaggregation appears as follows:



Summary

Inputs:

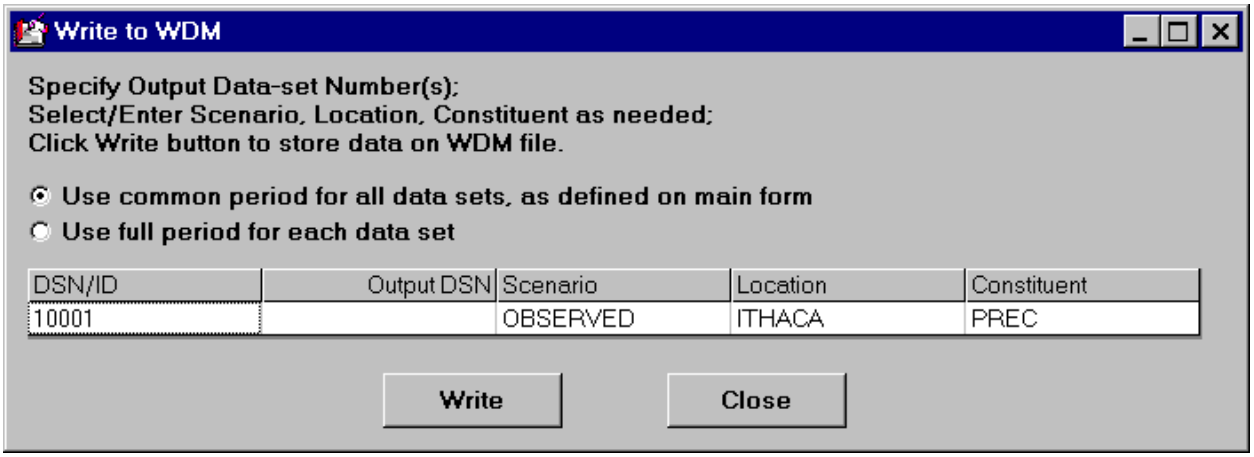
- Daily wind movement (any length units)
- Hourly distribution fractions (-)

Output:

- Hourly wind movement (same units as input)

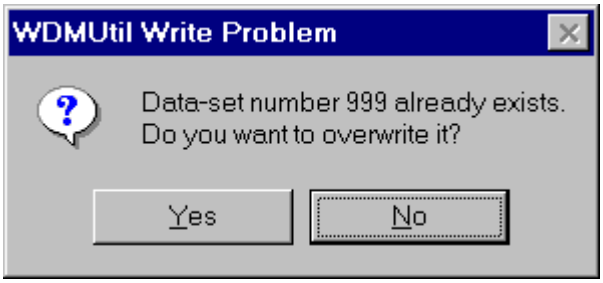
6 Writing to WDM

The Write to WDM form is displayed by clicking on the Write to WDM button in the Tools frame or by selecting the Analysis:Write menu item. At least one time series must be selected from the list in the Timeseries frame on the main form.



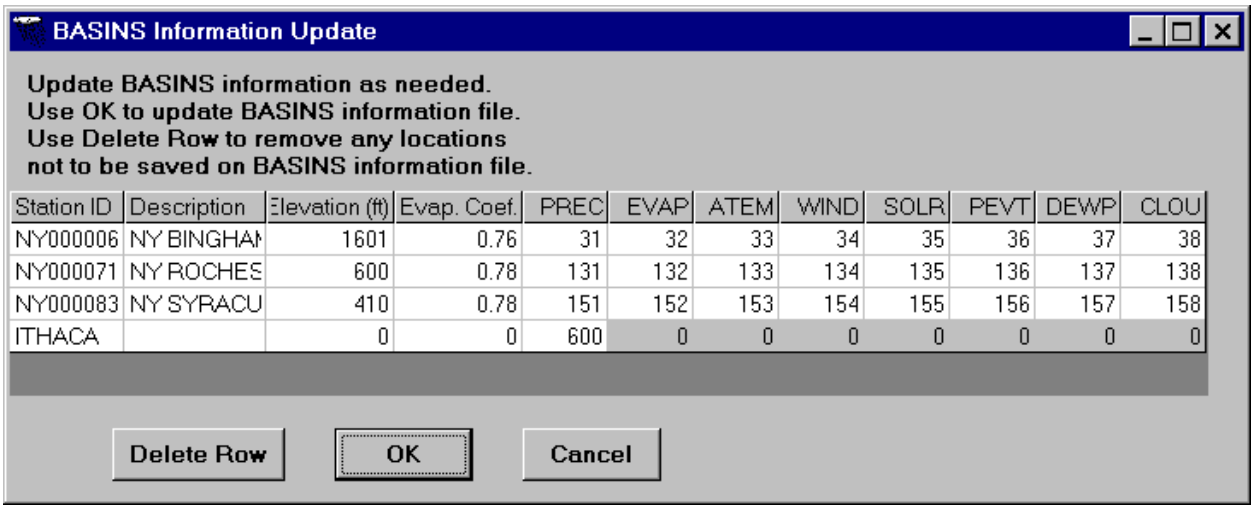
When more than one data set is being saved, an option is provided to save only the data in the time period common to all data sets or to save the full period of data for each data set. For each selected data set, a row is created on the Write to WDM form. Each row contains fields that describe the data set. The first column displays the current id number of the data set. This value may not be modified. The second column is for specifying the data-set number to which the data will be saved on the WDM file. A valid number (1 to 9999) must be entered in this field. The remaining columns display the current Scenario, Location, and Constituent names for the data set. If needed, these values may be modified by selecting an item from the pull-down list in each field, or by typing a new value.

Clicking the ‘Write’ button will cause each data set to be saved on the WDM file in the data-set number specified. If a specified data set already exists, the user will be asked whether or not to overwrite the data set.



Clicking the ‘Yes’ button will cause the new data to overwrite any existing data on that data set. Clicking the ‘No’ button will stop the writing process and return the user to the Write to WDM form.

When exiting the system (or closing a WDM file) after saving new data to the WDM file, WDMUtil will assist the user in transferring information about the new data to the BASINS Information File.



The BASINS Information Update form contains fields for specifying all of the information needed by BASINS about locations of meteorological data on the WDM file. Each row defines a unique location that will be made available to BASINS. The Station ID field is defaulted to the Location name for new data sets. The Description field is used to provide a more detailed description of the location. The Elevation and Evap. Coef. fields are used to enter required parameters associated with the location. The Description, Elevation, and Evaporation Coefficient fields must be defined by the user. The Constituent fields are used to indicate which data-set number contains the time-series data for each constituent. WDMUtil will fill the constituent fields with default data-set numbers as new data is saved to the WDM file.

It is possible to use the same data set for different locations. This allows a user to import a subset of data more local to their area of interest and then use existing data from nearby locations to fill in any missing constituents.

The 'Delete Row' button is used to ignore a new location and not store it on the BASINS information file. The 'OK' button is used to write the information on the form to the BASINS information file. The 'Cancel' button is used to stop the exiting (or closing) process and return to the main form.

7 References

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8 Appendices

8.1 BASINS Information File - *.inf

The BASINS information file is used to relate information in the WDM file to the BASINS Nonpoint Source Model (NPSM). Each WDM file is required to have a .inf file with exactly the same name (only the extensions are different: .wdm versus .inf). The information required for the .inf file includes the number of stations in the WDM file, various station information (state, name, ID #, elevation, period of record, and the evaporation coefficient), and the data-set numbers for each of the meteorological constituents for each station. For more information regarding BASINS information files, see appendix B.2 of the BASINS users manual.

8.2 Time-Series Watershed Data Management - *.wdm

The Time-Series WDM file is a binary file designed especially for storing time-series data. A WDM file is made up of data sets containg both data and attributes about the data. In order for data sets to be usable by WDMUtil, they must have non-blank values for three particular WDM attributes: IDSCEN, IDCONS, and IDLOCN. When a BASINS WDM file is first read by WDMUtil, it automatically updates the attributes on the data sets using information in the associated BASINS information file.

WDMUtil performs a significant suite of functions on WDM time-series data sets. However, some specialized functions such as deleting data sets and working with data-set attributes must still be performed using the utility program ANNIE.

8.3 NOAA NCDC Export Format - *.ncd

The National Climatic Data Center (NCDC) has archived a vast amount of meteorological data. To record these data in consistent formats, they have published formats for storing different types of meteorological data. WDMUtil is designed to read data that are in the NCDC archive format. The archive formats used by WDMUtil are documented in the following publications: TD-3200 Surface Land Daily Cooperative Summary of the Day, TD-3210 First Order Summary of the Day, TD-3240 Hourly Precipitation, and TD-3260 Fifteen Minute Precipitation. For documentation of these formats, see **http://www4.ncdc.noaa.gov/ol/documentlibrary/datasets.html**.

8.4 WDMUtil Message WDM

The Message WDM file is a binary file containing information necessary for the WDM system. This file contains information regarding available attributes to be associated with time-series data. For more information about this file see the documentation for the Annie system.